BIO CONTROLLER

ADI 1030

USER MANUAL

EU DECLARATION OF CONFORMITY

CE

The company Applikon Dependable Instruments B.V., Schiedam, The Netherlands, hereby certifies that the instrument:

ADI 1030 BIO CONTROLLER

meets the requirements of the EU Directives 89/336/EEC (Electromagnetic Compatibility) and 73/23/EEC (Low Voltage).

SOURCE OF THE SPECIFICATIONS:

89/336/EEC: EN 50081-1 (1992) EMC Generic emission standard. Residential, commercial and light industry.
EN 61000-3-2 (1995) EMC Limits for harmonic current emissions (equipment input current ≤ 16A per phase).
EN 61000-3-3 (1995) EMC Limits concerning voltage fluctuations and flicker for equipment having an input current up to and including 16 A per phase.
EN 50082-1 (1992) EMC Generic immunity standard. Residential, commercial and light industry.
EN 50082-2 (1995) EMC Generic immunity standard. Industrial environment (including table A.4).

73/23/EEC EN 61010 Safety requirements for electrical equipment for measurement, control and laboratory use.

ing J. van Burg, President. 21.08.96

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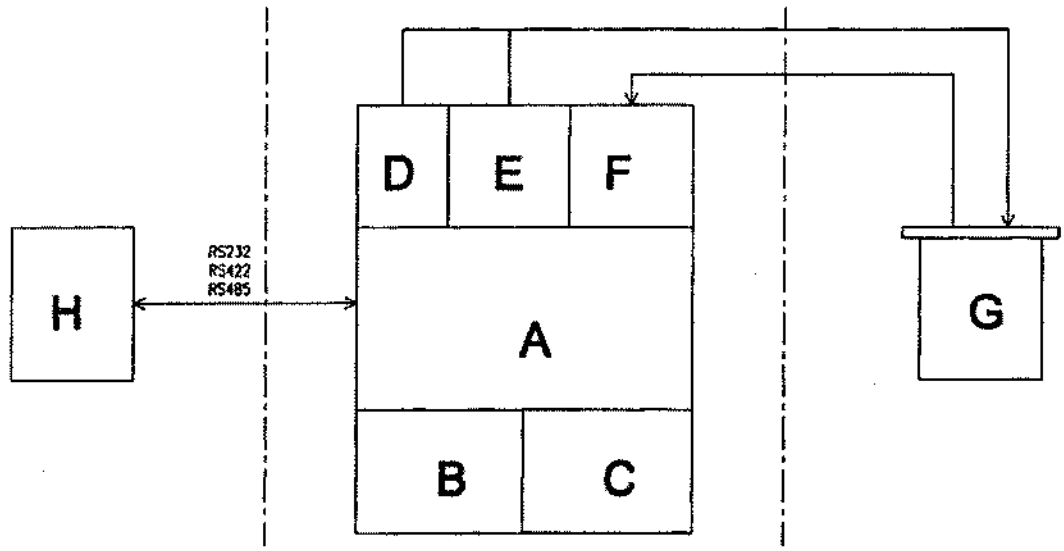
CHAPTER 1

INTRODUCTION

AND MAIN MENU

The ADI 1030 Bio Controller is a process controller, capable of measuring and controlling up to four parameters. The controller contains an 8-bit micro processor, loaded with flexible firmware that can control four parameters through eleven outputs (nine solid state and two analog outputs).
See figure below:



Schematic configuration of the Bio Controller ADI 1030

A = Controller Board ADI 1030
B = Keyboard
C = LCD Display
D = Analog Outputs (2x)
E = Digital Outputs (9x)
F = Sensor Modules (4x)
G = Bio Process
H = Host Computer

The display of the ADI 1030 consists of four lines (example is presented below):

36.7 °C	*29.3 %*	*6.50 pH*	*0.3 bar*
1 ↓ 25%	*3 ↓ 5%*	*6 ↑ 75%*	*11 ↑ 25%*
ADI1030 - MAIN MENU - BIO CONTROLLER			
PROCESS	MANUAL		LOGIN

line 1 shows the (maximum four) measured "process variables".
line 2 shows for each running controller:

- the controlled output number,
- the trend of the process value (below or above setpoint, approaching setpoint or drifting away:

  ↓: below setpoint, drifting away, ↓: below setpoint, approaching, +: at setpoint, ↑: above setpoint, approaching, ↑: above setpoint, drifting away.
- the controller output value (%).

line 3 showes the menu line of the firmware.
line 4 showes the functions of the function keys **F1** through **F5** (these functions depend on the selected menu, see line 3).

When de power was switched off in the "logout-mode" and the power is switched on again (press **F3** to continue), the lowest two display lines show the *MAIN MENU* status and the available MENU FUNCTIONS:

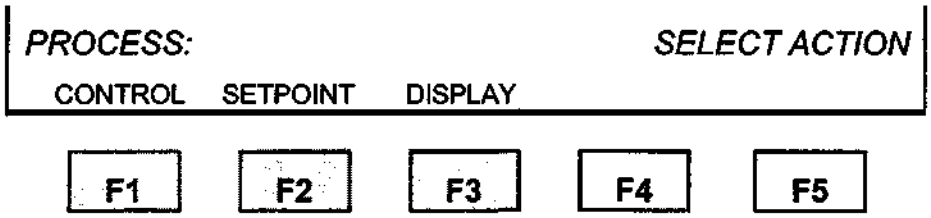
ADI 1030 - *MAIN MENU* - *BIO CONTROLLER*				
PROCESS	MANUAL			LOGIN
F1	**F2**	**F3**	**F4**	**F5**

Note:
- Shaded function keys are active.

CHAPTER 2

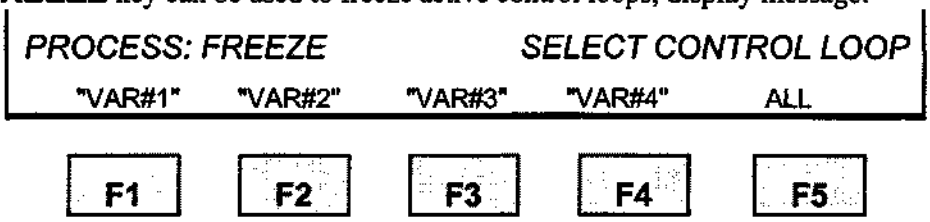
PROCESS MENU

After accessing the PROCESS menu (use **F1** in the MAIN menu), the lowest two display lines show:



The functions in this menu are explained in the following paragraphs.
The **UP** or the **MAIN** key will return to the MAIN menu.

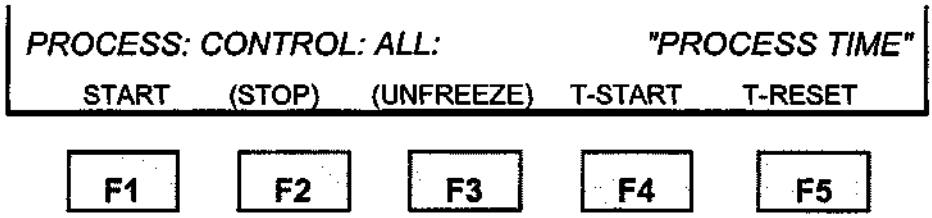
The **FREEZE** key can be used to freeze active control loops; display message:



The function keys **F1** through **F4** can be used to freeze one of the (active) loops; **F5** can be used to freeze all loops at the same time.
Function keys of loops that are not active are not presented.
When one (or more) control loops are frozen, the PROCESS: CONTROL: menu will contain the UNFREEZE option (see chapter 2.1.1 and 2.1.2)
When no control loops are started (active), the FREEZE-function can not be used (error message "NO ACTIVE CONTROL LOOP").

2.1.2 GENERAL VARIABLE SELECTION:

With function key **F5** (ALL), all four process variables are selected at the same time; the display shows:



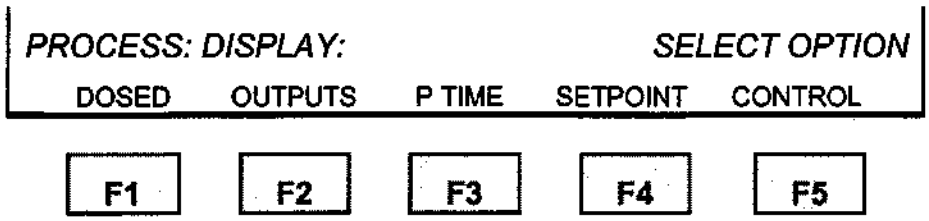
With **F1/F2**, control loops of all four process variables are started or stopped.
When one or more control loops are frozen, **F3** can be used to undo this.

Key **F4** has three different functions:

- If the process time = 0000:00:00 (HHHH:MM:SS) and not running, **F4** = T-START (pressing this key will start the process time counter); in this case, **F5** has no function.
- If the process time is not 0000:00:00 and not running, **F4** = T-CONT. and **F5** = T-RESET; **F4** will continue the process time counter, **F5** will reset the process time to 0000:00:00 (conformation is requested first).
- If the process time is running, **F4** = T-STOP (pressing this key will stop the process time counter); in this case, **F5** has no function.

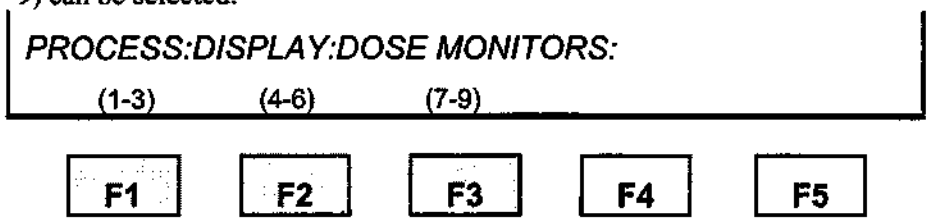
2.3 PROCESS-DISPLAY:

After selecting **F3** in the PROCESS menu, the display presents:

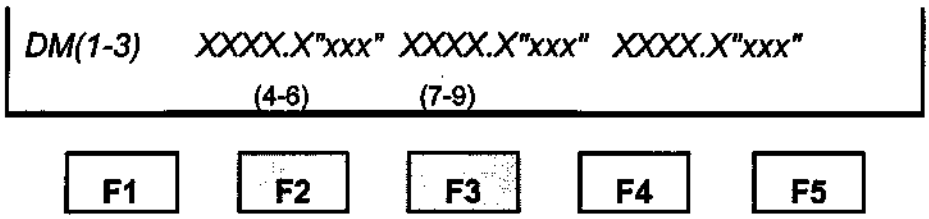


2.3.1 DISPLAY DOSE MONITOR VALUES:

After selecting **F1**, three groups of recorded values of dose monitor-outputs (1 - 3; 4 - 6 and 7 - 9) can be selected:



The function keys are used to select a group; pressing **F1** will result in the following display:



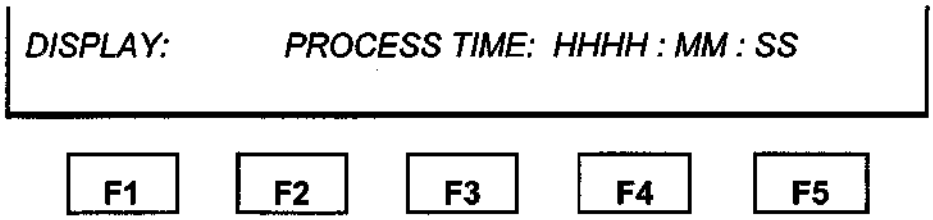
After use of key **F2** or **F3**, key **F1** will select Dose Monitors 1-3.

- The dose monitor values can be configured (see chapter 5) to present values in the following dimensions:
  - time (mn or hs),
  - volume (ml or l),
  - weight (g or kg),
  - power (J or kJ).

The dose monitor values are presented with floating point.
When a dose monitor value reaches 99999, it will be reset to 0.

2.3.3 DISPLAY PROCESS TIME:

After selection of **F3** in the DISPLAY menu, the process time will be displayed:

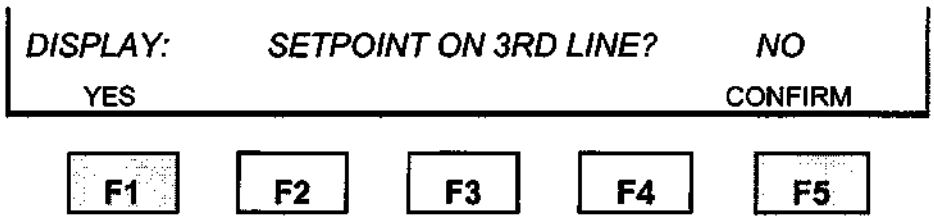


The **UP** key returns to the PROCESS-DISPLAY menu.

Note:
- Using this menu, the PROCESS TIME can only be recalled, not started or stopped (see the PROCESS-CONTROL-ALL menu).

2.3.4 DISPLAY SETPOINTS:

Key **F4** in the DISPLAY menu can be used to change the normal display lay-out; by enabling this option, the third display line will show the setpoints of all four control loops:



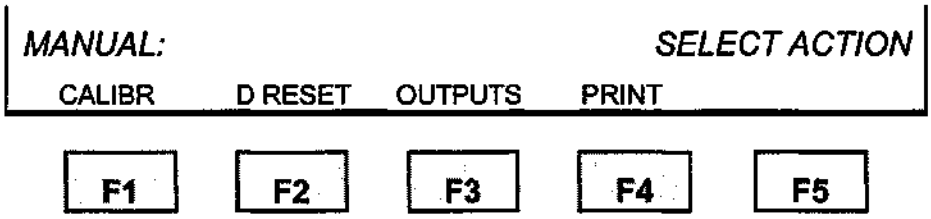
After pressing **F1** its function will change in NO; in this way the required lay-out of display line 3 can be set. **F5** (CONFIRM) key activates the selected option and returns to the PROCESS-DISPLAY menu.

Note:
- Pressing the MAIN key will activate the DISPLAY-SETPOINT mode.
- Pressing the MAIN key a second time will interrupt the DISPLAY-SETPOINT mode and the third display line will return to its normal lay-out.

CHAPTER 3

MANUAL MENU

After accessing the MANUAL menu (use **F2** in the MAIN menu), the lowest two display lines show:



Note:
- Depending on the setting in the configuration menu, (serial communication with a computer or graphical printing, see table below) and on the PROCESS TIME status, the MANUAL-PRINT menu might not be available.

Computer Connected (Y/N)	Printer Connected		Manual Print Option Available (Y/N)
	Graph Defined (Y/N)	P. Time Running (Y/N)	
Y	-	-	N
N	N	N	Y
N	Y	N	Y
N	Y	Y	N
N	N	Y	Y

3.1.1 pH CALIBRATION:

After selection of pH, the following options are available:

MANUAL:CALIBRATION:pH				*SELECT OPTION*
EXECUTE	DATA	DEFAULT	CORRECT	
F1	F2	F3	F4	F5

After pressing **F1**, the actual (two point) calibration is started.

In a cycle, the following data is requested:
- *BUFFER TEMP,*
- *FIRST BUFFER,*
- *SECOND BUFFER,*

The buffer temperature is used for the Nernst potential correction; after entering a buffer value, the sensor signal is scanned (display shows "MEASURING") until it is stable (drift < 0.02pH / 6 sec.).
If a calibration is executed once, the used buffer values are supposed to be default.

With help of these values and the two measured electrode signals, the calibration parameters are calculated: SLOPE (in relation to the Nernst potential) and OFFSET (differance from pH 7 at 0 mV) of the electrode.
At the end of the calibration procedure, the slope and offset are displayed at line three for five seconds (the **UP** key returns to the MANUAL-CALIBRATE menu).

F2 (DATA) displays the calibration data on the two lower display lines:

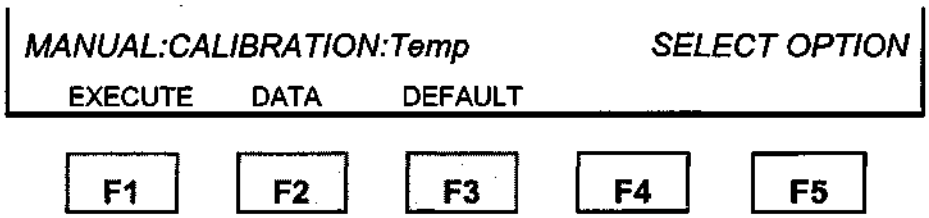
CALIB: "VAR#": SLOPE	*OFFSET*	*VALUE1*	*VALUE2*
X.XXX	XX.XX	XXX.XX	XXX.XX
F1	F2	F3	F4	F5

The **UP** key returns to the MANUAL-CALIBRATE-"VAR#" menu.

F3 (DEFAULT) resets the calibration data to default values: slope = 1.00, offset = 0.00 (display message for 5 sec.: "CALIBR "VAR#" RESET TO DEFAULT VALUES").

3.1.2 CALIBRATION OF TEMPERATURE:

The temperature calibration is required to ensure accurate readings over the full measuring range. The temperature calibration display shows:



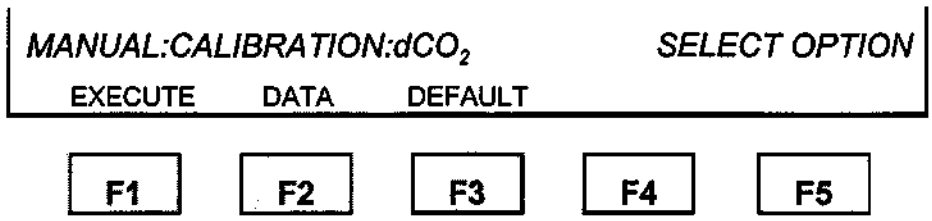
After pressing **F1**, the actual (two point) calibration is executed. In a cycle, the following data is requested:
- *FIRST VALUE*,
- *SECOND VALUE*,

After entering a temperature value, the sensor signal is scanned (display shows "MEASURING") until it is stable (drift < 0.2°C / 6 sec.).
With help of these values and the two measured electrode signals, the calibration parameters are calculated: SLOPE (in relation to the theoretical slope) and OFFSET (at 0 °C) of the electrode.
At the end of the calibration procedure, the slope and offset are displayed at line three (5 sec.). The **UP** key returns to the MANUAL-CALIBRATE menu.

F2 (DATA) and **F3** (DEFAULT) have the same function as in the pH calibration procedure.

3.1.4 dCO_2 CALIBRATION:

After selection of the dCO_2 calibration menu, the following options are available:



After pressing **F1**, the actual (two point) calibration is started.
Apart from the possibility to specify the buffer temperature, the dCO_2 calibration procedure is identical to the pH calibration.
Refer to the calibration instructions that come with the electrode.

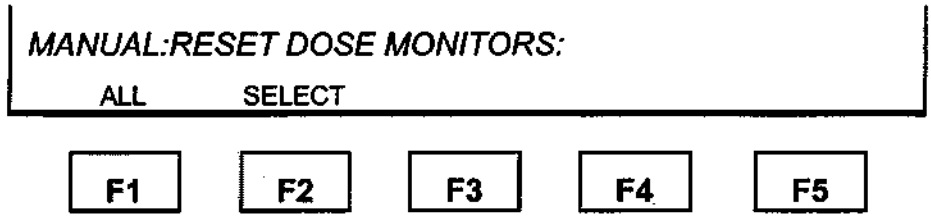
F2 (DATA) and **F3** (DEFAULT) have the same function as in the pH calibration procedure.

3.1.5 LEVEL CALIBRATION:

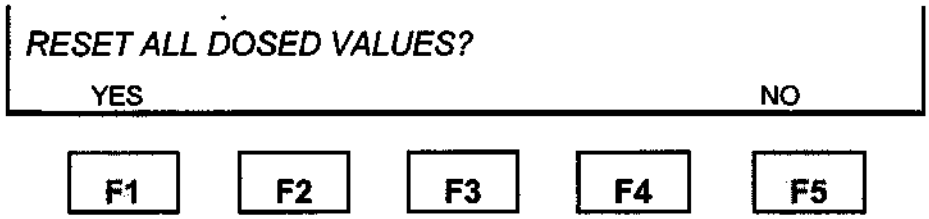
Level calibration only contains a sensitivity selection for level detection; when conductance drops below the selected level, contact is detected.
Possible selections:
F1 = 10 μS,
F2 = 15 μS,
F3 = 23 μS,
F4 = 100 μS,

3.2 RESET DOSE MONITOR VALUES:

In the RESET DOSE MONITOR menu, lines three and four of the display are presented in the following manner:

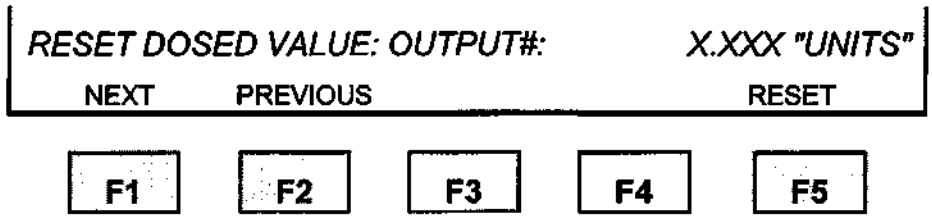


After selection of **F1**, a confirmation is requested before all dosed values are reset:



In case **F1** is pressed, all dosed values are reset (set to 0); pressing **F5** will return to the previous menu.

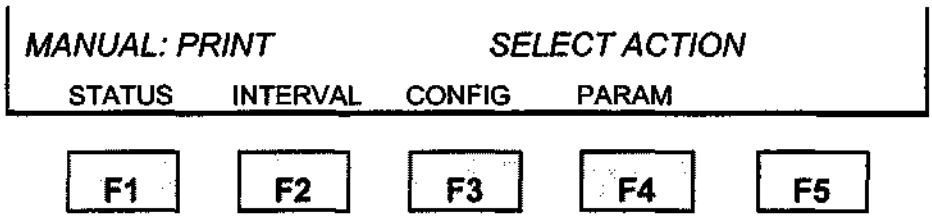
After selection of **F2**, the display shows the lowest output number that is defined as dose monitor:



F2 is functional after pressing **F1** once. Pressing **F5** will reset the dose monitor value to 0. When the highest output number is displayed, **F1** has no function.
If no output is defined as dose monitor, the error message: *NO DOSE MONITORS DEFINED* is generated.
The **UP** key will return to the MANUAL menu.

3.4 MANUAL-PRINT:

In case in the CONFIGURATION-SERIAL menu the printer option is selected, **F4** in the MANUAL menu can be used to select manual print-outs:



Note:
- In case the non-graphical printer mode is configured, manual print commands are valid at any time.
- In case the graphical printer mode is configured, manual print commands can only be issued when the Process Time counter is not running; in case the Process Time counter is running, the MANUAL-PRINT menu is not accessable (see also the table at page 3-1).

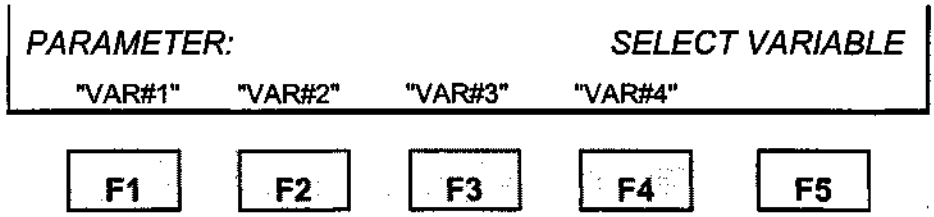
F1 (STATUS) generates a print-out of all input and output values (measured process variables, controller outputs, dose monitor values, analog outputs).
F2 (INTERVAL) will generate the same list of all input and output values periodically; the interval time must be set in minutes. Interval printing is deactivated by setting the interval time to 0 min.
F3 (CONFIG) generates a print-out of the configuration (per control loop: name and controller output## (normal and additional), alarm limits and output; also undefined or manual defined outputs are listed.
F4 (PARAM) generates the listing of all parameter settings of the four control loops.

Note:
- After entering a printer command, the message "XXXXXXXX:PRINTING" will be displayed for a 3 sec. period.
- In case the connected printer is not ready for data transfer (X-off) for an uninterrupted period of 2 minutes, a printer time-out message will be generated.

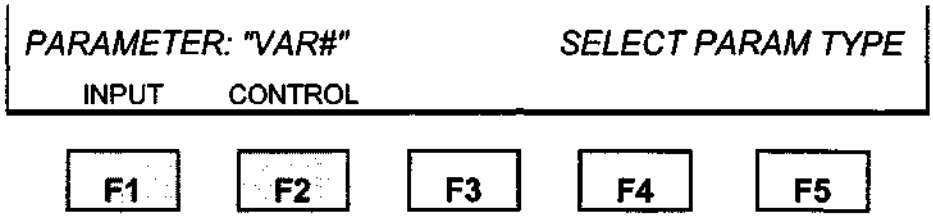
CHAPTER 4

PARAMETER MENU

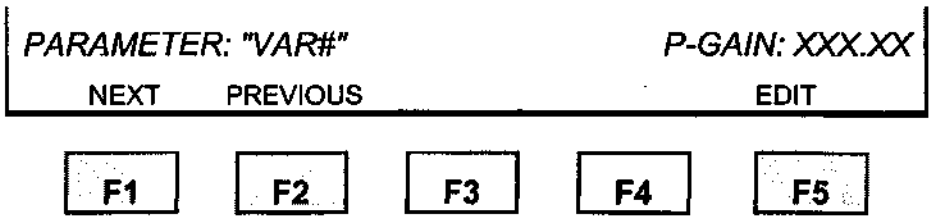
After accessing the PARAMETER menu (use **F3** in the MAIN menu), the lowest two display lines show:



After selection of the required process variable, the display shows:



After selection of **F1**, the input parameters are presented; after selection of **F2**, the control parameters are presented. Display (in case of control par.):

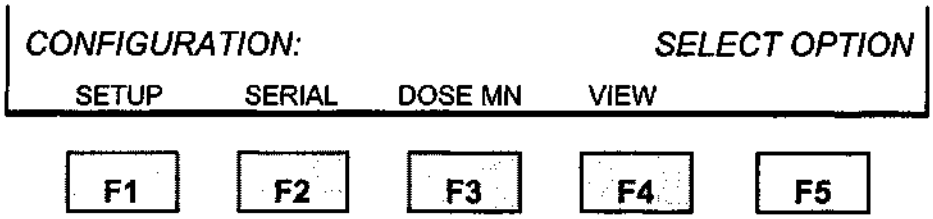


F2 only has the function PREVIOUS after pressing **F1** once; when the final parameter is reached, **F1** becomes functionless.
After pressing **F5** (EDIT), the parameter value can be updated with the numerical key-board; the menu now remains in the EDIT mode until the **UP** or **ENT**er key is issued.

CHAPTER 5

CONFIGURATION MENU

After accessing the CONFIGURATION menu (use **F4** in the MAIN menu), the lowest two display lines show:



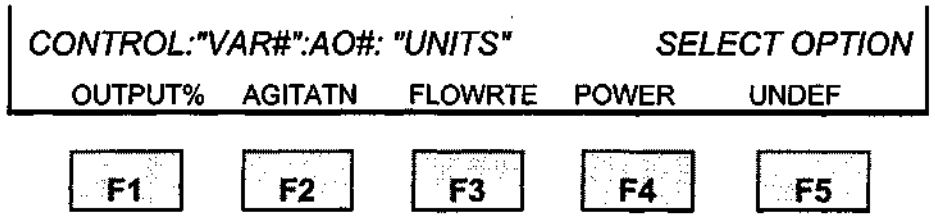
Configuration Setup:	hardware definition.
Configuration Serial:	definitions and setting of the serial port.
Configuration Dose Mn:	dose monitor definition of actuators that are connected to control loops.
Configuration View:	possibility to recall the defined configuration.

The proposed output number is the one with the lowest number that is undefined (**F5** = DEFINE) or already defined in this control loop in cascade order (**F5** = EDIT).
The function of **F2** (PREVIOUS) is only available after use of **F1**; when no extra outputs are available, **F1** becomes functionless.
Key **F5** defines/edits the proposed output number, after which the position regarding the setpoint must be specified:

F1 will define the selected output to be active below setpoint, **F2** will define the selected output to be active above setpoint.

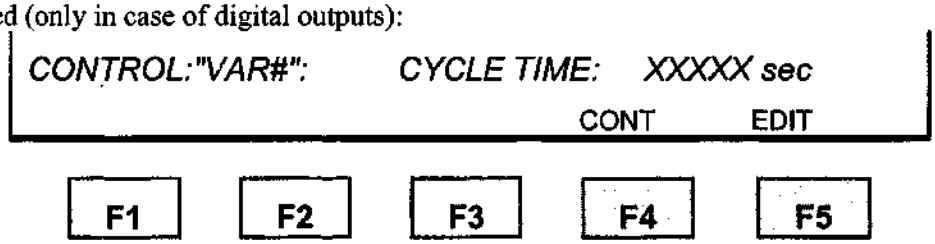
Note:
- In case of LEVEL CONTROL, the controller definition procedure is different, since in this case only one output can be defined, editted or deleted. After selecting the output number, the only other available selection is "NORMAL/INVERSE" as a manner of defining the actuator type (Normally Open or Normally Closed).

The next step is only presented in case of an analog output (in case of digital outputs, the next step will be: LOW LIMIT).



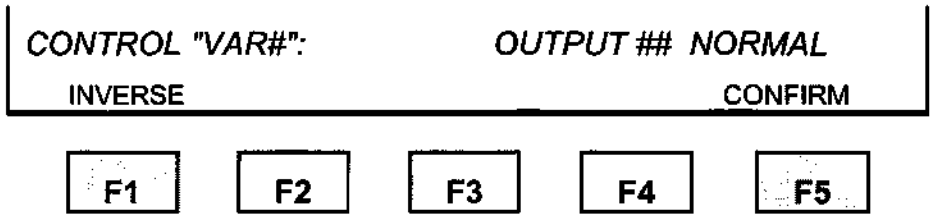
The engineering units that can be selected for each option, are listed in the table on the next page.

After entering numeric values for the limits, the cycle time of the selected output must be entered (only in case of digital outputs):



Use the numeric keyboard to enter this value.

Now the output can be defined to be a Normal or Inverse output (Inverse output means: Actuator Output = 100% when process value is at setpoint):



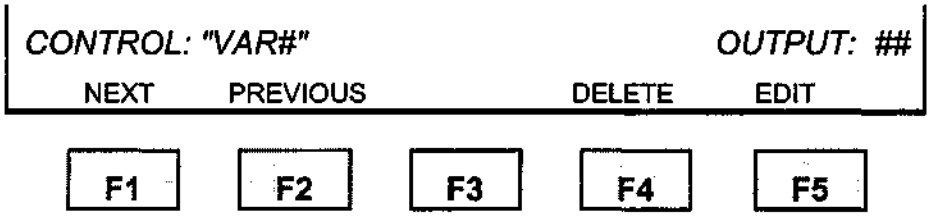
F1 toggles between NORMAL and INVERSE. After the Normal/Inverse definition of the output, the output configuration is finished; the configured output can be edited (see page 5-7) or an additional output can be configured by returning to the CONFIGURATION-SETUP-CONTROL menu.

DANGER: INVERSE definition of an output means that the actuator output is 100% when the process value is at setpoint or the control loop is not running. Before INVERSE definition of an output, disconnect the power supply of the output module of the ADI 1030. Do not reconnect this power supply of the output module before alle precautions are taken to prevent any accidents.

EDITTING AND/OR DELETING OUTPUTS FROM A CONTROLLER SETUP:

If a controller setup (outputs assignment or corresponding data) needs to be updated, this can easily be done according to the following procedure.

Enter the SETUP-CONTROL and select the corresponding process variable (control loop):



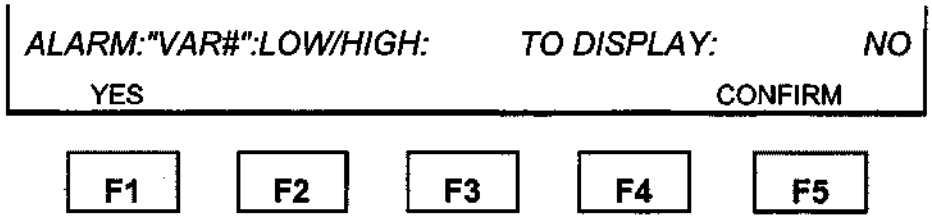
Use **F1** and/or **F2** until the output is displayed that should be updated or deleted.

In case **F5** (EDIT) is selected, the definition procedure is followed (same procedure as in case of the original setup definition) and each definition/setting can be editted.

In case **F4** (DELETE) is selected, the specified output is deleted from the Controller Setup Definition. After deleting an output by using **F4**, the display message "OUTPUT ## DELETED" is displayed (line 3; 5 sec. interval), after which will be returned to the Setup Control "Var#" menu.

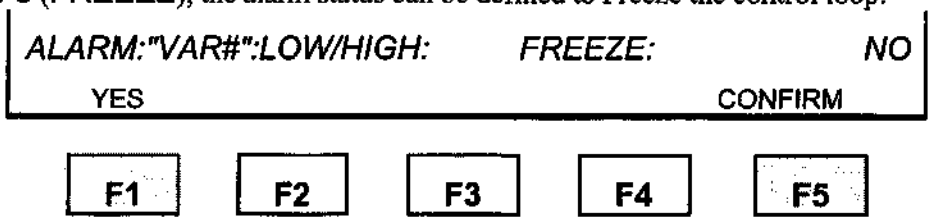
The proposed output number (only digital outputs) is the one with the lowest number that is still undefined (**F5** = DEFINE) or already defined as an alarm output (**F4** = DELETE).
The function of **F2** (PREVIOUS) is only available after use of **F1**; when no extra outputs are available, **F1** becomes functionless.
Key **F5** defines the proposed output number as an alarm output.
If no outputs are available for alarm definition, an error message is generated.

F2 (DISPLAY): in case of an occurring alarm, the alarm message is presented on display line 3; **F3** is used for acknowledge-purposes.



F1 toggles between YES and NO. **F5** confirms the selected action.

With **F3** (FREEZE), the alarm status can be defined to Freeze the control loop:

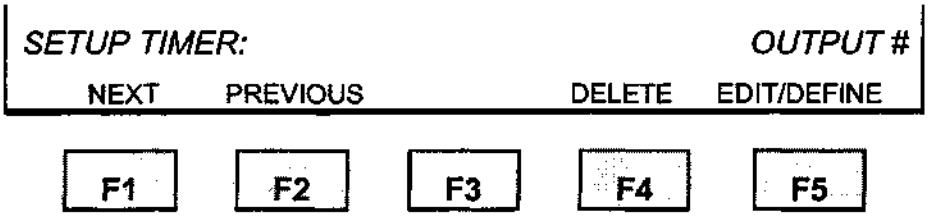


F1 toggles between YES and NO. **F5** selects the required action.

Note:
- In case an output is frozen because of an alarm, this Freeze status can be reset with help of the Process-Control menu.

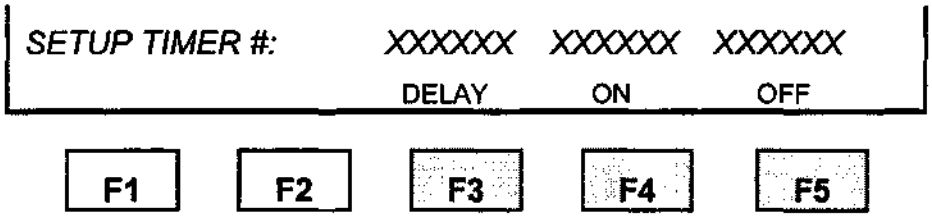
5.1.3 TIMER DEFINITIONS:

The function key **F3** (TIMER) in the CONFIGURATION SETUP is used for Timer definitions (a timer is a manual controlled output). Display:



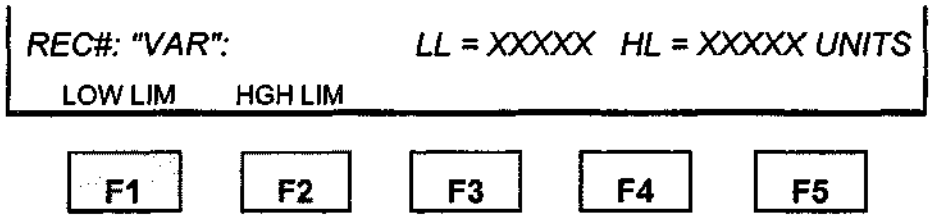
The proposed output number is the one with the lowest number that is still undefined (**F5** = DEFINE) or already defined as a timer output (**F4** = DELETE, **F5** = EDIT).
The function of **F2** (PREVIOUS) is only available after use of **F1**; when no extra outputs are available, **F1** becomes functionless.
Key **F5** selects the proposed output number as a timer output; in case the output number was already defined as a timer, function key **F4** can be used to delete this timer definition.
If no outputs are available for timer definition, an error message is generated.

Now the timer data must be set (HH:MM:SS):



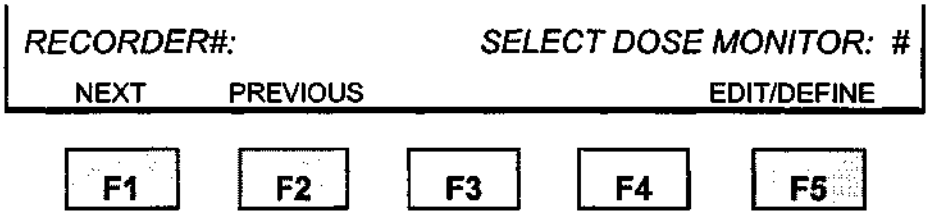
The **UP** key is used to return to the SETUP TIMER menu.

Note:
- Periods between 60 and 100 seconds are illegal and must be specified as 1 minute and a number of seconds.
- The timer function is an action that is manually defined; in the configuration menu, a delay-time, an on-time and an off-time can be set. In the MANUAL:OUTPUTS menu the Timer can be started or stopped. After starting a Timer, first the programmed Delay time will elapse, after which a continuous cycle of On- and Off-times will occur.



After pressing **F1** and **F2**, the values can be editted by use of the numerical key-board. After setting the limits, the **UP** key is used to return to the SETUP RECORDER menu.

When DOSE MN is selected, the dose monitor (digital output) number and the high limit (value to correspond to 20 mA) must be defined.



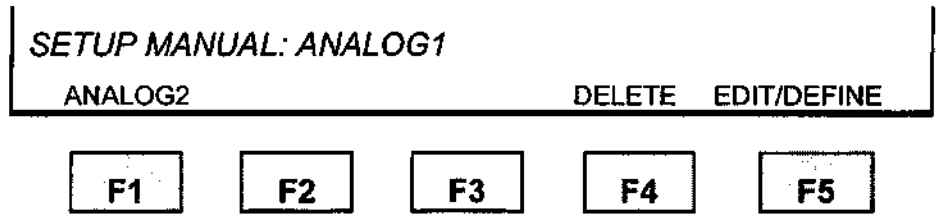
When no Dose Monitors are defined, the error message "NO DOSE MONITOR CONFIGURED" will be generated.
The proposed output number is the lowest digital output that is configured as a dose monitor (see also chapter 5.3); with **F1** the output number can be incremented (only digital outputs). **F5** selects the actual dose monitor. **F4** deletes an already selected dose monitor output.

The dose monitor values can be expressed in the following units (see chapter 5.3: configuration dose):

- Time (hs or mn),
- Volume (ml or l),
- Weight (g or kg),
- Power (J or kJ).

5.1.5 MANUAL DEFINITIONS:

An analog output can also be configured for manual operation; in this case, the output value can be manually controlled.
In this case, the following data must be specified:
- the engineering units of the available options (see table below),
- the maximum value that can be obtained (corresponds to 20 mA),
- the low limit of this output,
- the high limit of this output.

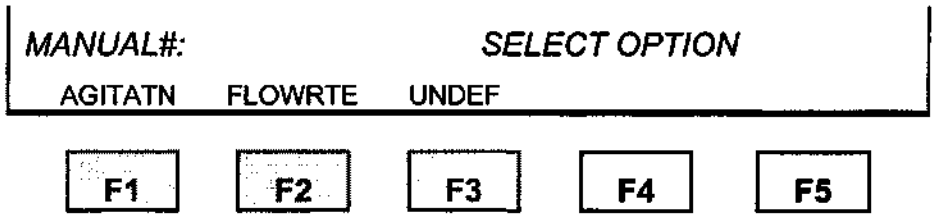


Key **F1** toggles between ANALOG2 and ANALOG1. (In case one of the analog outputs is configured in the RECORD mode, only one output remains; when both analog outputs are configured in the RECORD mode, the error message: NO ANALOG AVAILABLE is generated).

If an analog output was already defined as manual, the EDIT key can be used to change the maximum value, low and high limit values of this output.

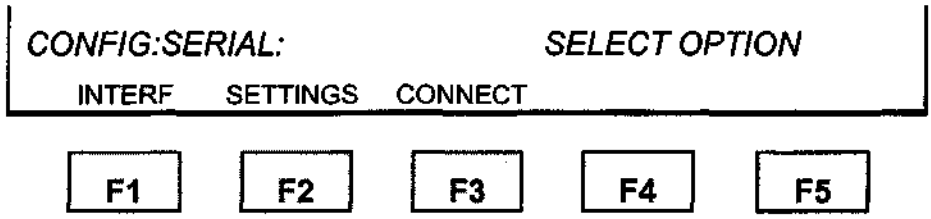
F5 defines the actual selection. If the analog output is already configured for manual operation, it can be edited or deleted.

Next the desired option must be specified:



5.2 CONFIGURATION SERIAL:

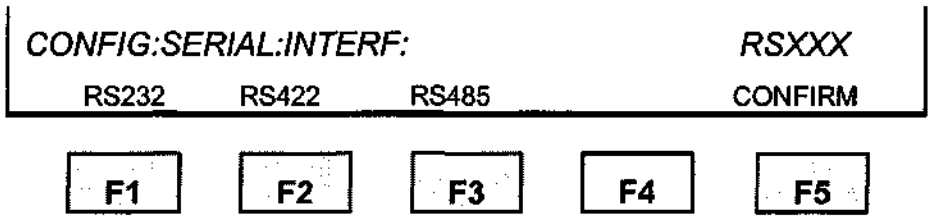
This menu is used to define the type and settings of serial communication:



Note:
- Information about the Applikon communication protocol and function codes to perform serial communication can be found in the ADI 1030 Serial Communication Manual.

5.2.1 INTERFACE SELECTION:

In case **F1** is selected in the SERIAL menu, the following menu is presented:

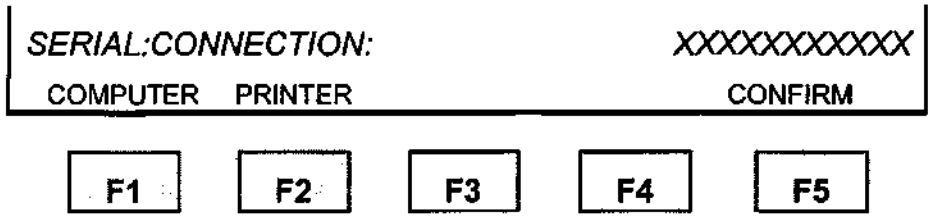


With function keys **F1** through **F3**, followed by **F5**, an interface type can be selected. Default interface selection is RS232; in case one of the other interfaces is selected, printer-functions are not longer valid.
However, if in the CONNECT menu the option PRINTER is selected, the options RS422 and RS485 are not present since the printer cannot communicate with these types of interfaces.

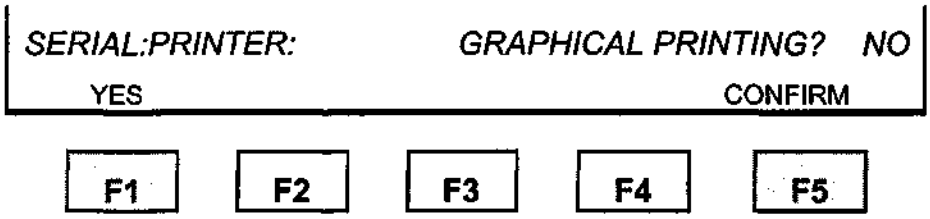
Note:
- If serial communication, using RS442/RS485 is required, the switch-positions 1, 2 and 3 at the controller board of the ADI 1030 must be altered. Refer to the Installation Manual of the ADI 1030 Bio Controller, chapter 1.3.5: Serial Communication.

5.2.3 PRINTER / COMPUTER CONNECTION:

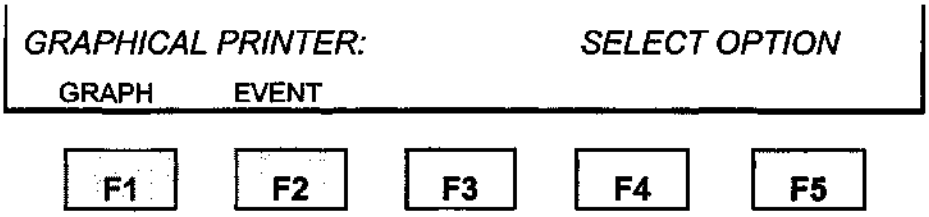
In case **F3** is selected in the SERIAL menu, the following menu is presented:



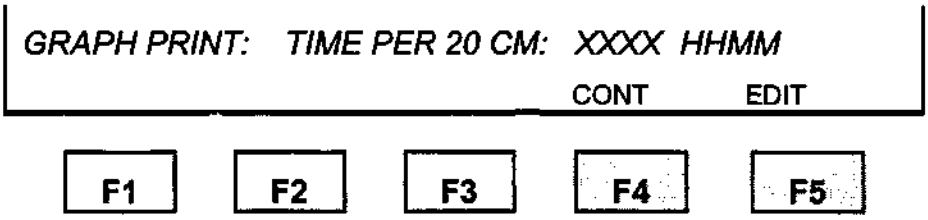
With function key **F2**, followed by key **F5**, the option PRINTER is selected, after which the following message is presented:



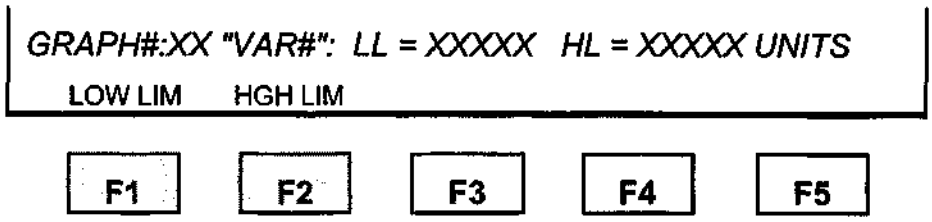
When NO is confirmed, the CONFIGURATION-SERIAL menu is presented again.
When YES is confirmed, the graphical printing mode must be defined:



After selecting **F1**, the trend of six signals can be configured; however, first the time (HH:MM) per 20 cm paper feed must be selected (default value = 12 hours):



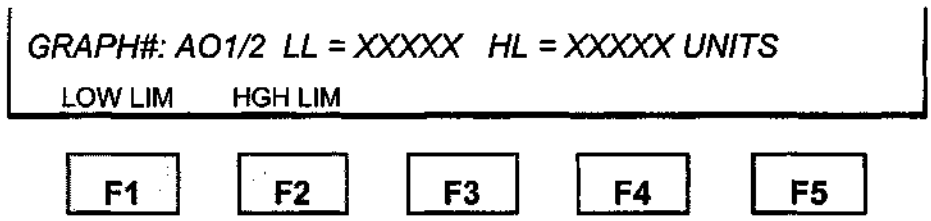
The input definition is finalized by the setting of low and high limits:



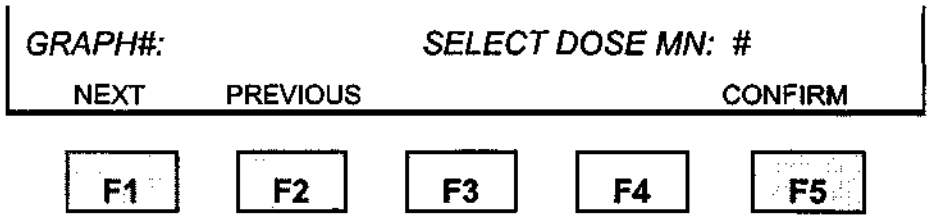
"XX" can be "IN" for input or "CO" for control signal.
After pressing **F1** and **F2**, the values can be editted by use of the numeric key-board. The **UP** key will return to the GRAPH PRINTER menu; other graph# can now be defined.

If the sixth was just defined, the GRAPH PRINTER generates the message: "*6 GRAPHS DEFINED*".

After output selection, the low and high limits must be specified (same procedure as for inputs):

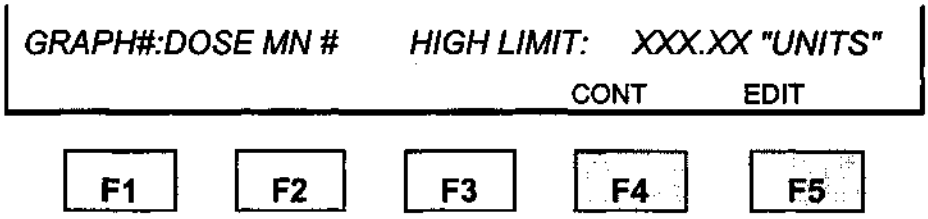


If **F4** (DOSE MN) is selected, a dose monitor function can be assigned to the solid state outputs and be recorded (see also 5.1.4: recording definitions).



The proposed output number is the lowest digital output that is defined as a dose monitor; with **F1** the output number can be incremented (only digital outputs). **F5** defines the actual selection.

Now the high limit must be specified:

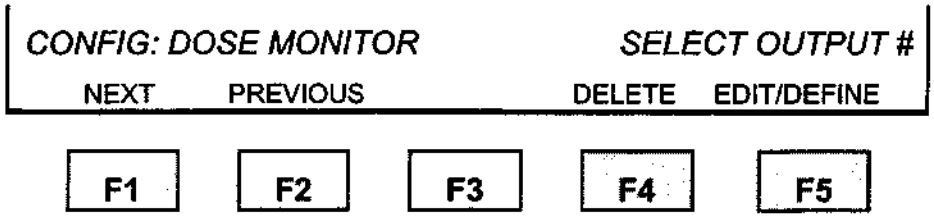


The high limit of the dose monitor can be entered, using the numeric key-board.

The **UP** key returns to the GRAPH PRINTER menu. Pressing the **UP** key again will return to the GRAPHICAL PRINTER menu.

5.3 CONFIGURATION DOSE:

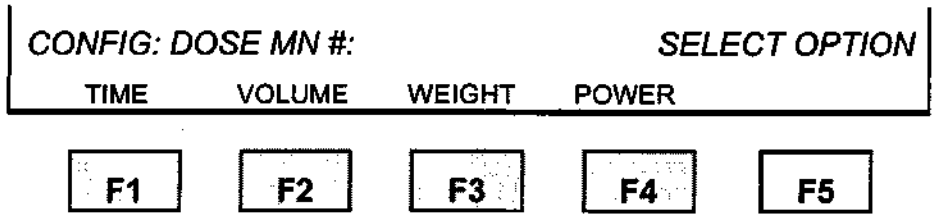
The CONFIGURATION-DOSE menu can be used to specify which outputs must be recorded by a "dose monitor" function (output action is integrated in time). First the output number must be defined, after which the desired engineering unit can be selected and the conversion factor (conversion of time to actuator action) can be set:



The proposed output number is 1; with **F1** the output number can be incremented (only digital outputs). **F5** defines the actual selection.

If the actual output # is already defined as a dose monitor, the edit and delete option are displayed (**F4** and **F5**).

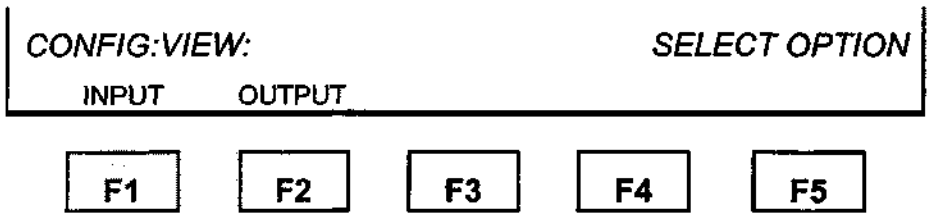
After selecting an output number for a dose monitor function, the desired option and engineering unit can be defined:



After option selection, the desired engineering unit can be selected with the function keys **F1** and **F2**.
Available engineering units:
Time : minutes or hours (mn or hs),
Volume : milliliters or liters (ml or l),
Weight : grams or kilograms (g or kg),
Power : Joules or kiloJoules (J or kJ).

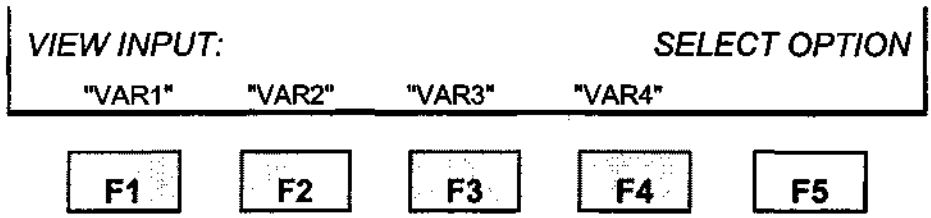
5.4 CONFIGURATION VIEW:

The CONFIGURATION-VIEW menu can be used to recall the different configuration definitions.



5.4.1 VIEW INPUT:

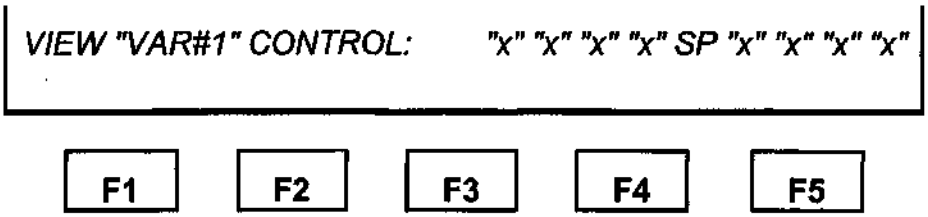
In the VIEW-INPUT menu first the process variable must be selected:



After selection of the required process variable, the following three options can be selected:

If no alarm limits or record configuration is programmed, the corresponding function key are omitted.

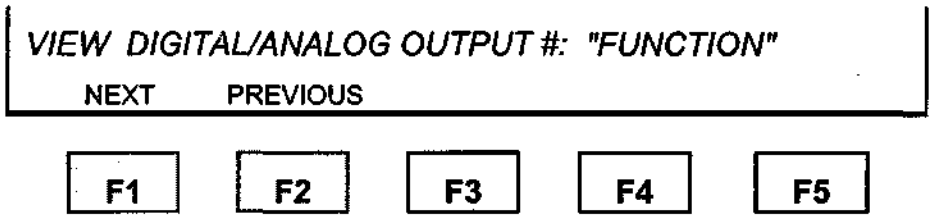
After pressing **F1**, the outputs that are assigned to this process variable are displayed:



On the positions "x" configured output numbers are be displayed (max. 4); positions left of SP are active below setpoint, positions right of SP are active above setpoint.
Inverse outputs are presented as "-x".

5.4.2 VIEW OUTPUT:

In the VIEW-OUTPUT menu the function of the digital and analog outputs can be scanned:



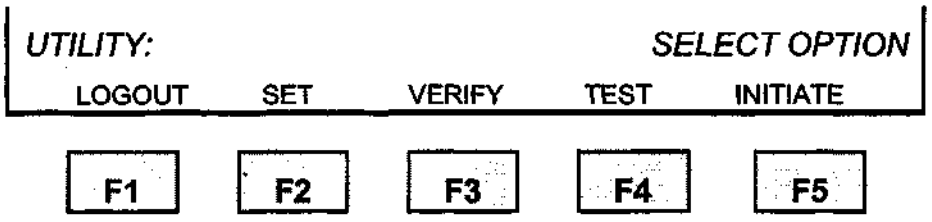
Possible functions are:
- Control (in case of digital outputs, the dose monitor function is also presented),
- Alarm (only digital outputs) (the dose monitor function is also presented),
- Timer (only digital outputs) (the dose monitor function is also presented),
- Recorder (only analog outputs),
- Manual (only analog outputs),
- Not Defined.

The VIEW-OUTPUT menu starts with digital output 1; after digital output 9, analog output 1 is presented.

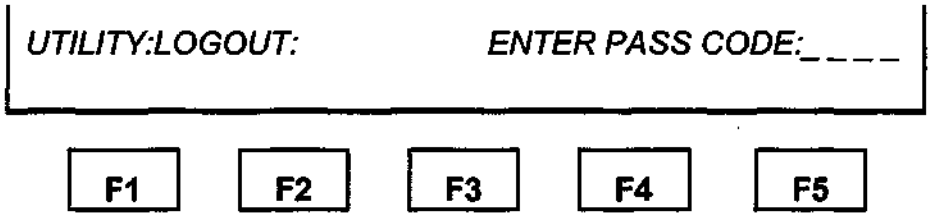
CHAPTER 6

UTILITY MENU

The UTILITY menu is used for additional settings and verifications; it has the following lay-out:

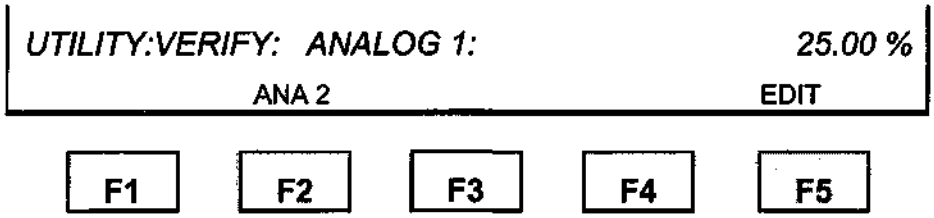


After selection of **F1**, the Logout procedure is executed:



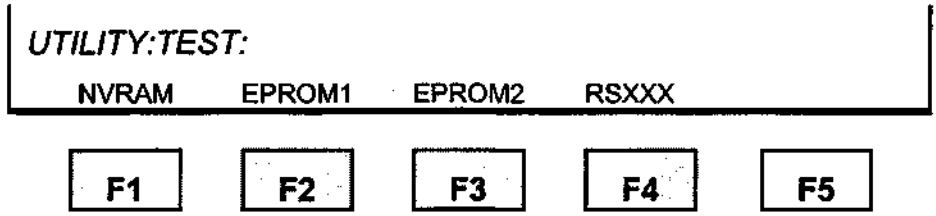
After entering the proper pass code, the Bio Controller is logged out; only the **PROCESS** and **MANUAL** menu are available for operator actions; parameter settings, configuration definitions and utility settings are secured.

Display-example of verification of an analog output:



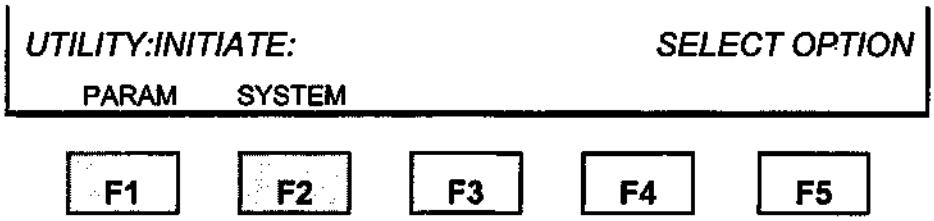
The default value of undefined outputs is "0".

After pressing **F4** (TEST), the following menu is presented:



F1 will start the test of the NVRAM: result: "OK" or "NOT OK".
F2 will start the test of the EPROM1: result: "OK" or "NOT OK" plus checksum.
F3 will start the test of the EPROM2: result: "OK" or "NOT OK" plus checksum.
F4 will start the test of the serial port: result: "SERIAL PORT OK" or "NOT OK" (in case of RS232/422 interface, the operator will be prompted to disconnect the cable for serial communication and to install a loop back connector; in case of RS485 interface, the network should be disconnected).

After pressing **F5** (INITIATE), it is possible to reset the input and PID control parameters or the whole system:



After pressing **F1**, the control variable that should be reset must be selected (VAR#1, VAR#2, VAR#3, VAR#4 or ALL); now all parameters are reset to default values; see table on next page.
After pressing **F2**, the confirmation for system-reset must be given (system-reset means deleting all configuration definitions; see next page for default settings).

BIO CONTROLLER

ADI 1030

OPERATOR MANUAL

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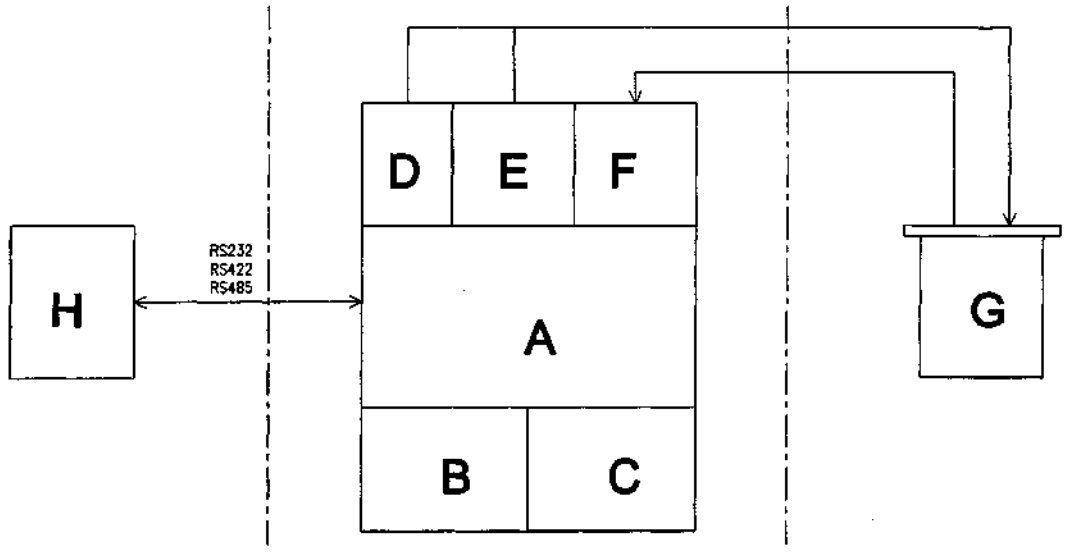
CHAPTER 1

INTRODUCTION

AND MAIN MENU

The ADI 1030 Bio Controller is a process controller, capable of measuring and controlling up to four parameters. The controller contains an 8-bit micro processor, loaded with flexible firmware that can control four parameters through eleven outputs (nine solid state and two analog outputs).
See figure below:



Schematic configuration of the Bio Controller ADI 1030

A = Controller Board ADI 1030
B = Keyboard
C = LCD Display
D = Analog Outputs (2x)
E = Digital Outputs (9x)
F = Sensor Modules (4x)
G = Bio Process
H = Host Computer

The display of the ADI 1030 consists of four lines (example is presented below):

36.7 °C	*29.3 %*	*6.50 pH*	*0.3 bar*
1 ⬇ 25%	*3 ⬇ 5%*	*6 ⬆ 75%*	*11 ⬆ 25%*
ADI1030 -	MAIN MENU -	BIO CONTROLLER	
PROCESS	MANUAL		LOGIN

line 1 shows the (maximum four) measured "process variables".
line 2 shows for each running controller:

- the controlled output number,
- the trend of the process value (below or above setpoint, approaching setpoint or drifting away:
  ⬇: below setpoint, drifting away, ⬇: below setpoint, approaching, ╋: at setpoint, ⬆: above setpoint, approaching, ⬆: above setpoint, drifting away.
- the controller output value (%).

line 3 showes the menu line of the firmware.
line 4 showes the functions of the function keys **F1** through **F5** (these functions depend on the selected menu, see line 3).

When de power was switched off in the "logout-mode" and the power is switched on again (press **F3** to continue), the lowest two display lines show the *MAIN MENU* status and the available MENU FUNCTIONS:

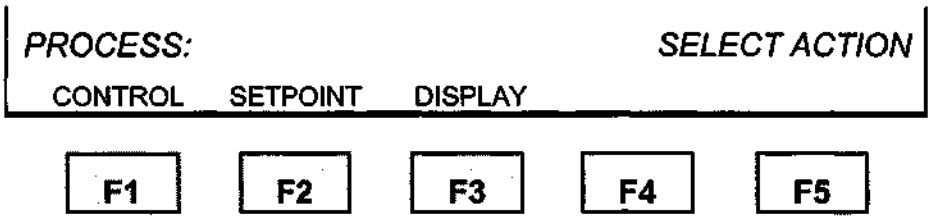
ADI 1030 -	*MAIN MENU* -	*BIO CONTROLLER*		
PROCESS	MANUAL			LOGIN
F1	**F2**	**F3**	**F4**	**F5**

Note:
- Shaded function keys are active.
- Operator actions can be executed with function keys **F1** and **F2**.
- The login procedure and configuration instructions can be found in the User Manual.

CHAPTER 2

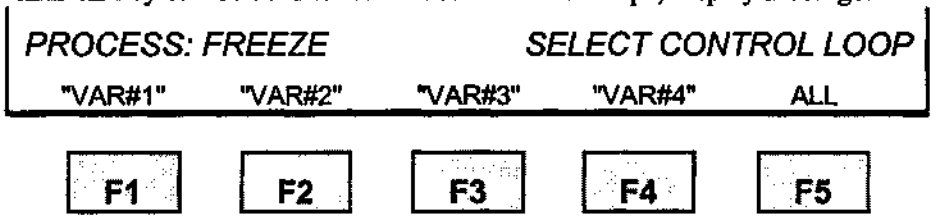
PROCESS MENU

After accessing the PROCESS menu (use **F1** in the MAIN menu), the lowest two display lines show:



The functions in this menu are explained in the following paragraphs.
The **UP** or the **MAIN** key will return to the MAIN menu.

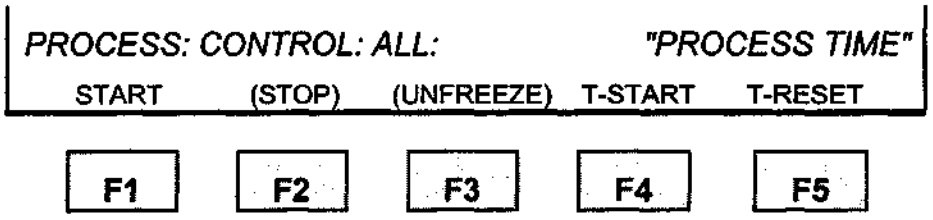
The **FREEZE** key can be used to freeze active control loops; display message:



The function keys **F1** through **F4** can be used to freeze one of the (active) loops; **F5** can be used to freeze all loops at the same time.
Function keys of loops that are not active are not presented.
When one (or more) control loops are frozen, the PROCESS: CONTROL: menu will contain the UNFREEZE option (see chapter 2.1.1 and 2.1.2)
When no control loops are started (active), the FREEZE-function can not be used (error message "NO ACTIVE CONTROL LOOP").

2.1.2 GENERAL VARIABLE SELECTION:

With function key **F5** (ALL), all four process variables are selected at the same time; the display shows:



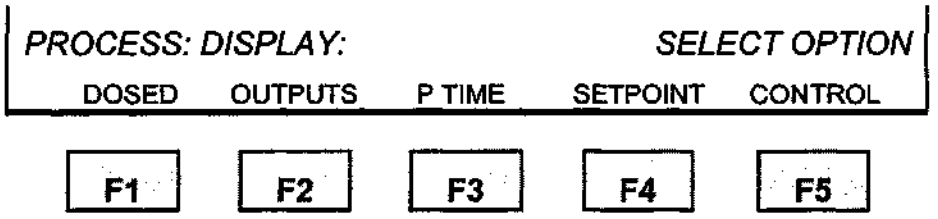
With **F1**/**F2**, control loops of all four process variables are started or stopped.
When one or more control loops are frozen, **F3** can be used to undo this.

Key **F4** has three different functions:

- If the process time = 0000:00:00 (HHHH:MM:SS) and not running, **F4** = T-START (pressing this key will start the process time counter); in this case, **F5** has no function.
- If the process time is not 0000:00:00 and not running, **F4** = T-CONT. and **F5** = T-RESET; **F4** will continue the process time counter, **F5** will reset the process time to 0000:00:00 (conformation is requested first).
- If the process time is running, **F4** = T-STOP (pressing this key will stop the process time counter); in this case, **F5** has no function.

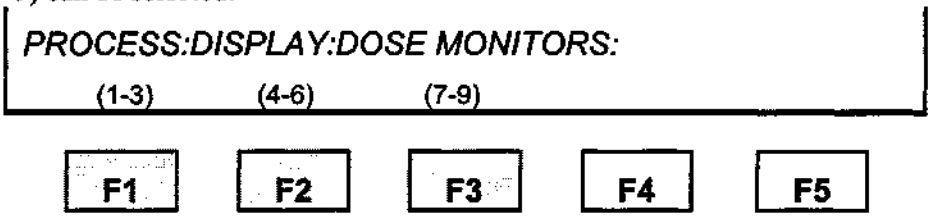
2.3 PROCESS-DISPLAY:

After selecting **F3** in the PROCESS menu, the display presents:

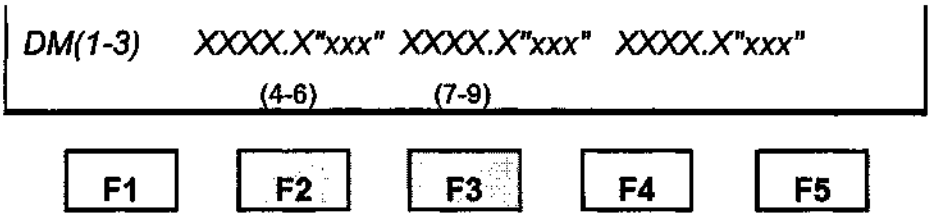


2.3.1 DISPLAY DOSE MONITOR VALUES:

After selecting **F1**, three groups of recorded values of dose monitor-outputs (1 - 3; 4 - 6 and 7 - 9) can be selected:



The function keys are used to select a group; pressing **F1** will result in the following display:



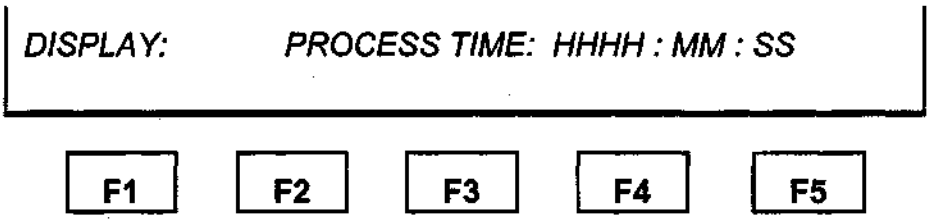
After use of key **F2** or **F3**, key **F1** will select Dose Monitors 1-3.

- The dose monitor values can be configured (see chapter 5) to present values in the following dimensions:
  - time (mn or hs),
  - volume (ml or l),
  - weight (g or kg),
  - power (J or kJ).

The dose monitor values are presented with floating point.
When a dose monitor value reaches 99999, it will be reset to 0.

2.3.3 DISPLAY PROCESS TIME:

After selection of **F3** in the DISPLAY menu, the process time will be displayed:

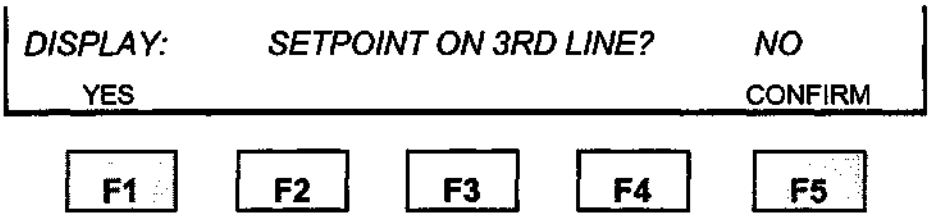


The **UP** key returns to the PROCESS-DISPLAY menu.

Note:
- Using this menu, the PROCESS TIME can only be recalled, not started or stopped (see the PROCESS-CONTROL-ALL menu).

2.3.4 DISPLAY SETPOINTS:

Key **F4** in the DISPLAY menu can be used to change the normal display lay-out; by enabling this option, the third display line will show the setpoints of all four control loops:



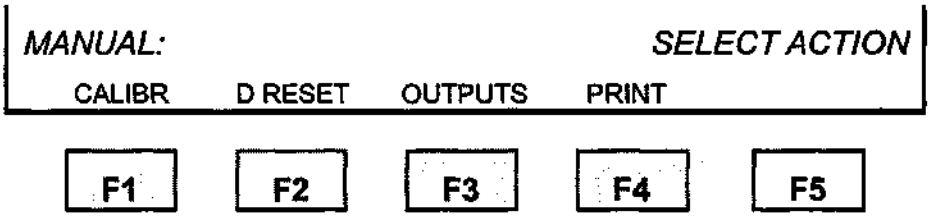
After pressing **F1** its function will change in NO; in this way the required lay-out of display line 3 can be set. **F5** (CONFIRM) key activates the selected option and returns to the PROCESS-DISPLAY menu.

Note:
- Pressing the MAIN key will activate the DISPLAY-SETPOINT mode.
- Pressing the MAIN key a second time will interrupt the DISPLAY-SETPOINT mode and the third display line will return to its normal lay-out.

CHAPTER 3

MANUAL MENU

After accessing the MANUAL menu (use **F2** in the MAIN menu), the lowest two display lines show:



Note:
- Depending on the setting in the configuration menu, (serial communication with a computer or graphical printing, see table below) and on the PROCESS TIME status, the MANUAL-PRINT menu might not be available.

Computer Connected (Y/N)	Printer Connected		Manual Print Option Available (Y/N)
	Graph Defined (Y/N)	P. Time Running (Y/N)	
Y	-	-	N
N	N	N	Y
N	Y	N	Y
N	Y	Y	N
N	N	Y	Y

3.1.1 pH CALIBRATION:

After selection of pH, the following options are available:

MANUAL:CALIBRATION:pH			*SELECT OPTION*	
EXECUTE	DATA	DEFAULT	CORRECT	
F1	F2	F3	F4	F5

After pressing **F1**, the actual (two point) calibration is started.

In a cycle, the following data is requested:
- *BUFFER TEMP*,
- *FIRST BUFFER*,
- *SECOND BUFFER*,

The buffer temperature is used for the Nernst potential correction; after entering a buffer value, the sensor signal is scanned (display shows "MEASURING") until it is stable (drift < 0.02pH / 6 sec.).
If a calibration is executed once, the used buffer values are supposed to be default.

With help of these values and the two measured electrode signals, the calibration parameters are calculated: SLOPE (in relation to the Nernst potential) and OFFSET (differance from pH 7 at 0 mV) of the electrode.
At the end of the calibration procedure, the slope and offset are displayed at line three for five seconds (the **UP** key returns to the MANUAL-CALIBRATE menu).

F2 (DATA) displays the calibration data on the two lower display lines:

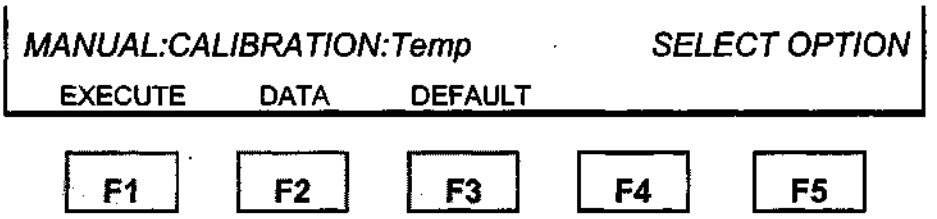
CALIB: "VAR#": SLOPE	*OFFSET*	*VALUE1*	*VALUE2*
X.XXX	XX.XX	XXX.XX	XXX.XX
F1	F2	F3	F4	F5

The **UP** key returns to the MANUAL-CALIBRATE-"VAR#" menu.

F3 (DEFAULT) resets the calibration data to default values: slope = 1.00, offset = 0.00 (display message for 5 sec.: CALIBR "VAR#" RESET TO DEFAULT VALUES").

3.1.2 CALIBRATION OF TEMPERATURE:

The temperature calibration is required to ensure accurate readings over the full measuring range. The temperature calibration display shows:



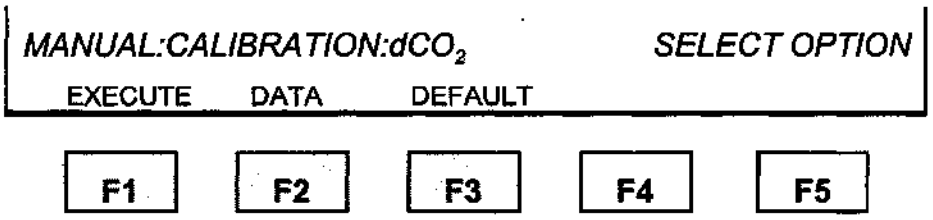
After pressing **F1**, the actual (two point) calibration is executed. In a cycle, the following data is requested:
- *FIRST VALUE*,
- *SECOND VALUE*,

After entering a temperature value, the sensor signal is scanned (display shows "MEASURING") until it is stable (drift < 0.2°C / 6 sec.).
With help of these values and the two measured electrode signals, the calibration parameters are calculated: SLOPE (in relation to the theoretical slope) and OFFSET (at 0 °C) of the electrode.
At the end of the calibration procedure, the slope and offset are displayed at line three (5 sec.). The **UP** key returns to the MANUAL-CALIBRATE menu.

F2 (DATA) and **F3** (DEFAULT) have the same function as in the pH calibration procedure.

3.1.4 dCO_2 CALIBRATION:

After selection of the dCO_2 calibration menu, the following options are available:



After pressing **F1**, the actual (two point) calibration is started.
Apart from the possibility to specify the buffer temperature, the dCO_2 calibration procedure is identical to the pH calibration.
Refer to the calibration instructions that come with the electrode.

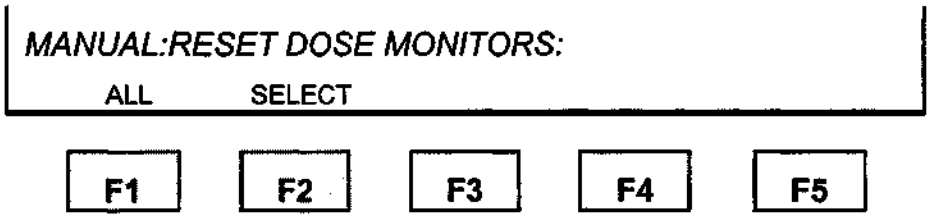
F2 (DATA) and **F3** (DEFAULT) have the same function as in the pH calibration procedure.

3.1.5 LEVEL CALIBRATION:

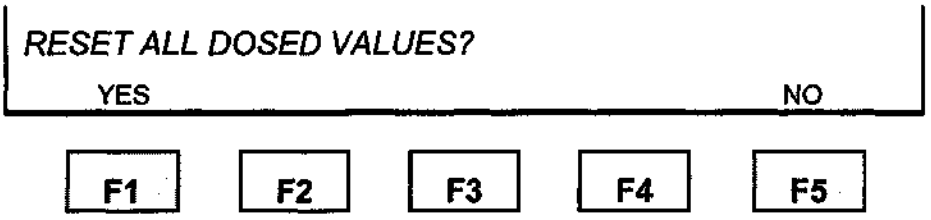
Level calibration only contains a sensitivity selection for level detection; when conductance drops below the selected level, contact is detected.
Possible selections:
F1 = 10 μS,
F2 = 15 μS,
F3 = 23 μS,
F4 = 100 μS,

3.2 RESET DOSE MONITOR VALUES:

In the RESET DOSE MONITOR menu, lines three and four of the display are presented in the following manner:

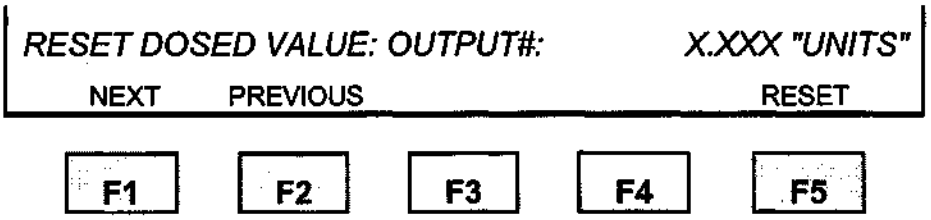


After selection of **F1**, a confirmation is requested before all dosed values are reset:



In case **F1** is pressed, all dosed values are reset (set to 0); pressing **F5** will return to the previous menu.

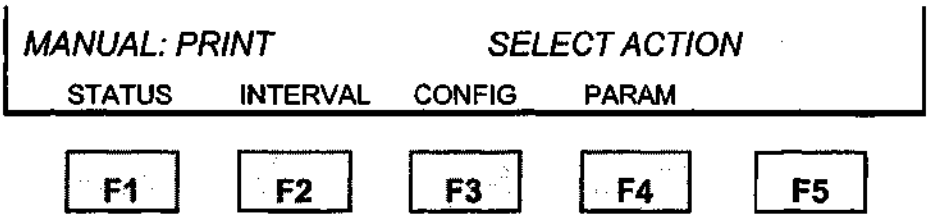
After selection of **F2**, the display shows the lowest output number that is defined as dose monitor:



F2 is functional after pressing **F1** once. Pressing **F5** will reset the dose monitor value to 0. When the highest output number is displayed, **F1** has no function.
If no output is defined as dose monitor, the error message: *NO DOSE MONITORS DEFINED* is generated.
The **UP** key will return to the MANUAL menu.

3.4 MANUAL-PRINT:

In case in the CONFIGURATION-SERIAL menu the printer option is selected, **F4** in the MANUAL menu can be used to select manual print-outs:



Note:
- In case the non-graphical printer mode is configured, manual print commands are valid at any time.
- In case the graphical printer mode is configured, manual print commands can only be issued when the Process Time counter is not running; in case the Process Time counter is running, the MANUAL-PRINT menu is not accessable (see also the table at page 3-1).

F1 (STATUS) generates a print-out of all input and output values (measured process variables, controller outputs, dose monitor values, analog outputs).
F2 (INTERVAL) will generate the same list of all input and output values periodically; the interval time must be set in minutes. Interval printing is deactivated by setting the interval time to 0 min.
F3 (CONFIG) generates a print-out of the configuration (per control loop: name and controller output## (normal and additional), alarm limits and output; also undefined or manual defined outputs are listed.
F4 (PARAM) generates the listing of all parameter settings of the four control loops.

Note:
- After entering a printer command, the message "XXXXXXXX:PRINTING" will be displayed for a 3 sec. period.
- In case the connected printer is not ready for data transfer (X-off) for an uninterrupted period of 2 minutes, a printer time-out message will be generated.

BIO CONTROLLER

ADI 1030

SERIAL COMMUNICATION MANUAL

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SERIAL COMMUNICATION

1. INTRODUCTION:

The ADI 1030 has a serial-interface that can be used for several purposes:

1. Connection with a PRINTER, print-out configuration, etc.
2. Connection with a COMPUTER (through RS232 or RS422 communication), reading values, changing settings, etc.
3. Connection with a NETWORK (through RS485 communication), reading values, changing settings, etc. at multiple devices.

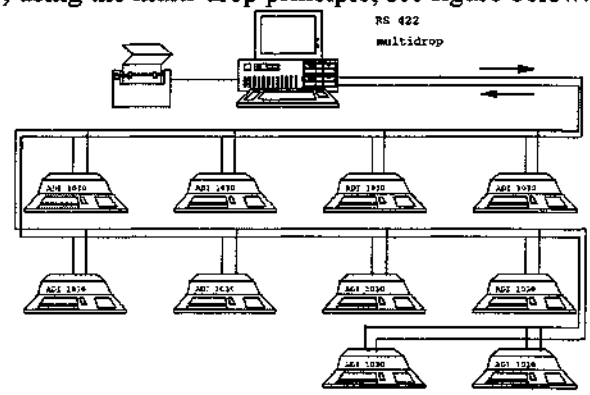
The Printer option is already discussed in the chapter Manual Operation.
The options RS232/422 and RS485 provide a bidirectional communication link between the Bio Controller and a HOST (e.g. PC). The serial-interface should be set to R232 or RS422/RS485 (see the Configuration-Serial menu) in order to communicate with a HOST.
Note that the interface-selection in the Configuration-Serial menu only selects the "firmware-interface" (i.e. the way the firmware handles the serial-interface); the hardware-selection is done on the Controller Board (refer to the ADI 1030 Installation Manual).

When the serial-interface is set to RS232, the Bio Controller can communicate with a HOST (only a one-to-one connection can be made: single Bio Controller, single HOST).
When the serial interface is set to RS422, up to 10 Bio Controllers can be connected to a single HOST.

Note:
When the RS-422 interface is used with multiple Bio Controllers, a strict master-slave mechanism should be used; the host should not send a next command before the reply to the previous command is returned, else (undetectable) data-collision will occur.

RS 422 CONFIGURATION:

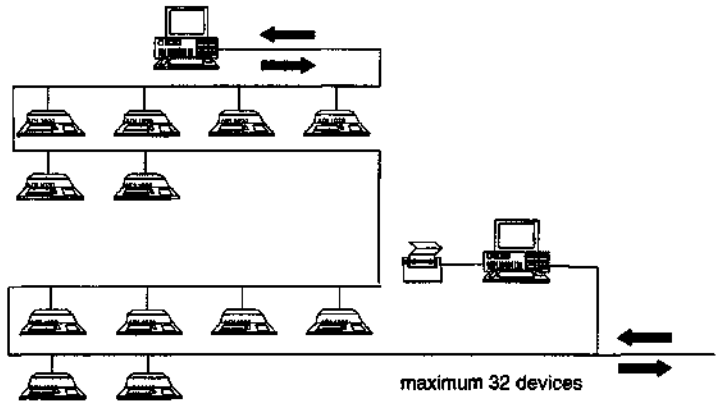
Using the RS422 interface, one or more Bio Controllers (max. 10) can be connected to a (personal) computer, using the multi-drop principle; see figure below:



When more than one Bio Controller is connected to a computer, using the RS422 interface, the computer uses the station number of each Bio Controller as an ID#; this is called multi-drop.
The typical characteristic is that this is always a "master"-"slave" configuration.

RS 485 CONFIGURATION:

When using the RS485 interface, the computer and Bio Controllers can be configured as a 'network'; see figure below:



Typical characteristic of a network is that each station can become the master.

The Command-separator has 3 possible forms: the character "**C**", the character "**A**" or the character "**E**".
When the command-string is send by the HOST, "**C**" is used to denote a COMMAND (this can be a request for data or a command).
When the Bio Controller replies to the command, "**A**" is used to return the requested data or to acknowledge the command; "**E**" is used to report an error.

The DATA-section holds the data to be used for the function(s). When the HOST sends data to the Bio Controller, it uses the Data-section to transport it; when the HOST requests data from the Bio Controller, the Data-section must be empty (in fact, an empty data-section marks a request).
Note that when a function is an implicit command (i.e. a function that doesn't need data to perform some action) the Data-Section is also empty.

The CHECKSUM-section is optional and holds both the Checksum-separator '/' and the checksum itself. The checksum consists of two characters which represent a byte-value. This byte-value is the checksum of the transmitted data.

The command-string always ends with a **<CR>** (carriage return), the use of a **<LF>** (line feed) is optional.

2.2 INSTRUCTION-SECTION:

The instruction-section is the section that addresses a specific function or a group/list of functions of the Bio Controller. Therefore, this section should always be used.
The Instruction-Section starts with the Mode-Character (F, B or L) which selects the mode to be used.
The other data in the instruction-section depends on the Mode being used, so the different modes will be discussed now with the relevant data.

FUNCTION-MODE:

The FUNCTION-Mode is the primary-mode, used by the ADI-protocol; all other modes are supersets of the Function-Mode.
All information that is retrieved from or send to the Bio Controller uses the Function-Code to address a specific function.
The Function-Code is build hierarchically, formed by several base-groups.

These base-groups are: 0 - utilities
1 - input-values
2 - input-control
3 - controller output/configuration
4 - output-control
5 - output
6 - operation-control

The base-groups are divided into several sub-groups. These are discussed later in this section.

These groups and sub-groups are addressed using numbers; together, these numbers form the Function-Code.
All numbers are separated by periods, creating the format: ***Fn.m.o.p ... z*** (e.g. F3.3.1).
The maximum number of sub-groups (or items) is not defined by the protocol itself; the ADI 1030 Bio Controller has a maximum of 6 items.

When a function-code is not available, an error will be returned:

example:
command: <*STX*>F0.5.1C<*CR*> (unknown function)
reply: <*STX*>F0.5.1**E32**<*CR*><*LF*> (error-32)

Note that the <*STX*>, <*CR*> and <*LF*> character will be omitted in the examples from now on.

LIST-MODE:

The LIST-mode can be used to request (not command) a predefined (programmed) LIST of function-codes that are addressed with a corresponding List-Number.
This list of functions is programmed using the ADI-protocol.

A LIST can be programmed in the following order:
- Clear any previous items of list x,
- Program line 1 of list x,
- Program line 2 of list x,
- ..
- ..
- Program line last of list x.

Clearing an existing list: ***<STX>L**listNumber**C0<CR>***
Programming a new line: ***<STX>L**listNumber**C**lineNumber,functionCode<CR>*

Example of programming lists:

Command:	L1C0	(clear list-1 completely)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L1C1,0.3.2	(program: list-1, line-1: time)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L1C2,3.2.1.1	(program: list-1, line-2: controller output pH1)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L1C3,3.2.2.1	(program: list-1, line-3: controller output temp1)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L1C4,3.2.3.1	(program: list-1, line-4: controller output DO1)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L1C5,3.2.5.1	(program: list-1, line-5: controller output level1)
Reply:	L1A	(acknowledge by ADI 1030)
Command:	L2C0	(clear list-2 completely)
Reply:	L2A	(acknowledge by ADI 1030)
Command:	L2C1,0.3.2	(program: list-2, line-1: time)
Reply:	L2A	(acknowledge by ADI 1030)
Command:	L2C2,1.1.1.1	(program: list-2, line-2: input value of pH1)
Reply:	L2A	(acknowledge by ADI 1030)
Command:	L2C3,1.1.2.1	(program: list-2, line-2: input value of temp1)
Reply:	L2A	(acknowledge by ADI 1030)
Command:	L2C2,1.1.3.1	(program: list-2, line-2: input value of DO1)
Reply:	L2A	(acknowledge by ADI 1030)
Command:	L2C2,1.1.5.1	(program: list-2, line-2: input value of level1)
Reply:	L2A	(acknowledge by ADI 1030)

2.3 UNIT-MODE:

The maximum length of the command string is limited (128 characters). The unit mode however makes it possible to exceed this maximum number of characters.
When one of the ADI Instruments (working with this ADI protocol) creates a reply-string that contains more than 128 characters, it automatically splits the string into UNITs. Only the first unit is send:
example:

command:	L4c	(request List-4)
reply:	L4U1a**0@** .. **0@0@**	(reply of first UNIT)

The host must acknowledge this first unit:

command:	L4U1c	(acknowledge Unit-1)
reply:	L4U2a**0@0@** .. **0@0@**	(reply second Unit)

this process continues until the last Unit is replied by the ADI Instrument:

command:	L4U4c	(acknowledge Unit-4)
reply:	L4U0a**0@0@0@0@**	(reply last Unit, always Unit-0)

The last unit is always marked as Unit-0, so the receiver can see that this is the **last** unit. The host does not have to acknowledge the last unit.

When the ADI Instrument decides to switch to the Unit-mode (because the reply string exceeds 128 characters) and the host does not acknowledge this but requests another function, error 39 (compound message error) is generated; whenever error 39 is generated, the internal Unit-mode mechanism is put in hold until the proper reply is received.

The UNIT-mode mechanism can be reset (without generating an error) by sending (from Host to ADI Instrument) the command F0.

The UNIT-mode can also handle the REPEAT command to request the last unit once again. In that case the ADI Instrument simply replies the same unit again:
example:

command:	L4U3c	(acknowledge Unit-3)
reply:	L4U4a**0@0@** .. **0@0@**	(reply unit-4)
command:	L4U4c**R**	(repeat command Unit-4)
reply:	L4U4a**0@0@** .. **0@0@**	(reply unit-4 again)

Note:
- The ADI 1030 Bio Controller does not make use of up/down loadable user programs, so the application of the unit-mode will not occur very often. An example where the unit mode will be used is requesting all four display lines in a block.

2.5 DATA-SECTION:

The DATA-section holds the data to be used for the function(s). When the HOST sends data to the Bio Controller, it uses the Data-section to transport it; when the HOST requests data from the Bio Controller, the Data-section must be empty (in fact, an empty data-section normally marks a request).
When a function is an implicit command (i.e. a function that doesn't need data to perform some action) the Data-Section is also empty.

When the command-separator indicates an error, the data-section contains the error-code. The error-code is a 2-digit number representing the type of error; see the ERROR-CODES section for a complete list and discussion of all possible errors.

The contents of the data-section can be numeric (digits) as well as alpha-numeric (characters and digits), depending on the function. The fast-float notation is an alpha-numeric notation of numeric-data.
The length of the data-sections is restricted by the maximum length of the command-string, which is 128 bytes. When all sections in the command-string are used to the maximum, only 92 characters remain for the data-section; not using the module-section and not padding with 0's (e.g. F000.001.001, which is legal) leaves 100 characters to the data-section in worst-case.

The characters in the data-sections should all be readable 7-bits ASCII-characters (to be precise, ASCII only defines 7-bits characters). Readable means that the first 32 ASCII-characters (which are *control-characters*, like <CR> or <TAB>) should not be used.
The IBM-extension on the ASCII-definition is not supported; this means that the degree Celsius sign ('°'), which is available in the IBM-extension characterset, can not be transmitted by the ADI-protocol. When for example the contents of the display lines are requested, all non ASCII-characters are replaced by underscore ('_').

The number of characters returned for a numeric-value totally depends on the function that is requested. The total number of digits (including the minus and decimal-point) is always restricted to 8. The number of digits on the right-side of the decimal-point depends on the function. Some functions are integer by nature (e.g. output-number), others have a fixed number of decimals (e.g. pH-value) and some have a floating number of decimals (e.g. dose monitor values).
However, the maximum number of decimals is restricted to 2. When the magnitude of the numeric-value is too large to be represented using its predefined format, first the number of decimals is diminished. If the magnitude is still too large, the digits are replaced by the *overflow* notation '>>>>>>>>' (the number of greater-than signs is equal to the maximum number of characters).
When the numeric-value has an underflow (e.i. too low to be represented using the maximum number of decimals), the overflow-notation is also used.

2.6 CHECKSUM-SECTION:

The CHECKSUM-section is optional and holds both the Checksum-separator '/' and the checksum itself. The checksum consists of two characters which represent a byte-value. This byte-value is the checksum of the transmitted data, starting with the <STX>-character inclusive and ending at the Checksum-separator inclusive. The checksum is calculated by adding all ASCII-values of the characters (e.g A = 65) discarding the carry (overflow when the sum exceeds 255, result is the remainder of sum / 256). The checksum is transmitted using a method like the ADI-fastfloat notation, in this case the *fastbyte* notation. First the low-nibble (lowest 4-bits) of the byte-value is converted into a character on the range [0..?], second the high-nibble is converted into a character in the range [@..O] (see Fast-Float mode for more details).
The transmitted checksum (the checksum in the checksum-section) should be equal to the checksum of the received characters (calculated by the receiver); if the checksum is not equal, the Bio Controller returns error-24 (checksum error).

If the Host uses the checksum-option, the ADI 1030 Bio Controller will also return it.

example of checksum calculation:

command:	<*STX*>F0.1.1C/	
byte-values:	2 + 70 + 48 + 46 + 49 + 46 + 49 + 67 + 47	
sum:	424	
checksum:	424 mod 256 = 168	
low-nibble:	168 mod 16 = 8	character = '8'
high-nibble:	168 div 16 = 10	character = 'J'
command-string:	<*STX*>F0.1.1C/8J<*CR*>	

FUNCTION GROUP 2: INPUT CONTROL

F-code	Functional Description	Range	Format float or # of chars.	Read Write Command
2.1.1.n.1	Slope of pH input n (n = 1 - 4)*		f	R
2.1.1.n.2	Offset of pH input n (n = 1 - 4)*		f	R
2.1.1.n.3	First buffer value for pH input n (n = 1 - 4)*	0 - 20	f	R
2.1.1.n.4	Second buffer value for pH input n (n = 1 - 4)*	0 - 20	f	R
2.1.1.n.5	Buffer temperature for pH input n (n = 1 - 4)*	0 - 150	f	R
2.1.2.n.1	Slope of temp input n (n = 1 - 4)*		f	R
2.1.2.n.2	Offset of temp input n (n = 1 - 4)*		f	R
2.1.2.n.3	First calibration value for temp input n (n = 1 - 4)*	0 - 150	f	R
2.1.2.n.4	Second calibration value for temp input n (n = 1 - 4)*	0 - 150	f	R
2.1.3.n.1	Slope of dO_2 input n (n = 1 - 4)*		f	R
2.1.3.n.2	Offset of dO_2 input n (n = 1 - 4)*		f	R
2.1.3.n.3	First calibration value for dO_2 input n (n = 1 - 4)*	0 - 500	f	R
2.1.3.n.4	Second calibration value for dO_2 input n (n = 1 - 4)*	0 - 500	f	R
2.1.4.n.1	Slope of dCO_2 input n (n = 1 - 4)*		f	R
2.1.4.n.2	Offset of dCO_2 input n (n = 1 - 4)*		f	R
2.1.4.n.3	First calibration value for dCO_2 input n (n = 1 - 4)*	0 - 100	f	R
2.1.4.n.4	Second calibration value for dCO_2 input n (n = 1 - 4)*	0 - 100	f	R
2.1.7.n.1	Slope of mV/mA input n (n = 1 - 4)*		f	R
2.1.7.n.2	Offset of mV/mA input n (n = 1 - 4)*		f	R
2.1.7.n.3	First calibration value for mV/mA input n (n = 1 - 4)*	0 - 1000	f	R
2.1.7.n.4	Second calibration value for mV/mA input n (n = 1 - 4)*	0 - 1000	f	R
2.2.1.n.1	Correction Sample value (and command)(n = 1 - 4)*	0 - 20	f	W
2.2.1.n.2	Correction Method (1 = fixed, 2 = use input)(n = 1 - 4)* see 1.4	1, 2	f	RW
2.2.1.n.3	Value for temperature correction (temperature or input number)*	0 - 150	f	RW
2.3.1.n.1	Engineering unit of pH input (n = 1 -4)*	0 - 33	f	RW
2.3.2.n.1	Engineering unit of temp input (n = 1 - 4)*	0 - 33	f	RW
2.3.3.n.1	Engineering unit of dO_2 input (n = 1 - 4)*	0 - 33	f	RW
2.3.4.n.1	Engineering unit of dCO_2 input (n = 1 - 4)*	0 - 33	f	RW
2.3.5.n.1	Engineering unit of level input (n = 1 - 4)*	0 - 33	f	RW
2.3.6.n.1	Engineering unit of Redox input (n = 1 - 4)*	0 - 33	f	RW
2.3.7.n.1	Engineering unit of mV/mA input (n = 1 - 4)*	0 - 33	f	RW
	t = 1:pH, t = 2:Temp., t = 3:dO_2, t = 4: dCO_2, t = 5:Level t = 6:Redox, t = 7:mV/mA, n = 1 - 4*			
2.4.t.n.1	Alarm status of input (0 = no alarm, 1 = low alarm, 2 = high alarm)	0,1,2	f	R
2.4.t.n.2	Low alarm limit (not valid for level input)	-	f	RW
2.4.t.n.3	High alarm limit (not valid for level input)	-	f	RW
2.4.t.n.4	Hysteresis on alarm limits (not valid for level input)	-	f	RW
2.4.t.n.5	Digital output number for Low alarm	0 - 9	f	RW
2.4.t.n.6	Digital output number for High alarm	0 - 9	f	RW
2.4.t.n.7	Low alarm to display (0 = no, 1 = yes)	0,1	f	RW
2.4.t.n.8	High alarm to display (0 = no, 1 = yes)	0,1	f	RW
2.4.t.n.9	Low alarm freezes controller (0 = no, 1 = yes)	0,1	f	RW
2.4.t.n.10	High alarm freezes controller (0 = no, 1 = yes)	0,1	f	RW

FUNCTION GROUP 3: CONTROLLER OUTPUT/CONFIGURATION

F-code	Functional Description	Range	Format float or # of chars.	Read Write Command
	n = 1 - 4*			
3.1.1.n.1	Setpoint of pH control loop		f	RW
3.1.1.n.2	Dead zone of pH control loop		f	RW
3.1.1.n.3	"currently not in use"		f	R
3.1.1.n.4	"currently not in use"		f	R
3.1.1.n.5	P gain of pH control loop		f	RW
3.1.1.n.6	I interval of pH control loop		f	RW
3.1.1.n.7	D interval of pH control loop		f	RW
3.1.1.n.8	Bias of pH control loop	-/+400	f	RW
3.1.1.n.9	Freeze value of pH control loop	-/+400	f	RW
	n = 1 - 4*			
3.1.2.n.1	Setpoint of temp control loop		f	RW
3.1.2.n.2	Dead zone of temp control loop		f	RW
3.1.2.n.3	"currently not in use"		f	R
3.1.2.n.4	"currently not in use"		f	R
3.1.2.n.5	P gain of temp control loop		f	RW
3.1.2.n.6	I interval of temp control loop		f	RW
3.1.2.n.7	D interval of temp control loop		f	RW
3.1.2.n.8	Bias of temp control loop	-/+400	f	RW
3.1.2.n.9	Freeze value of temp control loop	-/+400	f	RW
	n = 1 - 4*			
3.1.3.n.1	Setpoint of dO_2 control loop		f	RW
3.1.3.n.2	Dead zone of dO_2 control loop		f	RW
3.1.3.n.3	"currently not in use"		f	R
3.1.3.n.4	"currently not in use"		f	R
3.1.3.n.5	P gain of dO_2 control loop		f	RW
3.1.3.n.6	I interval of dO_2 control loop		f	RW
3.1.3.n.7	D interval of dO_2 control loop		f	RW
3.1.3.n.8	Bias of dO_2 control loop	-/+400	f	RW
3.1.3.n.9	Freeze value of dO_2 control loop	-/+400	f	RW
	n = 1 - 4*			
3.1.4.n.1	Setpoint of dCO_2 control loop		f	RW
3.1.4.n.2	Dead zone of dCO_2 control loop		f	RW
3.1.4.n.3	"currently not in use"		f	R
3.1.4.n.4	"currently not in use"		f	R
3.1.4.n.5	P gain of dCO_2 control loop		f	RW
3.1.4.n.6	I interval of dCO_2 control loop		f	RW
3.1.4.n.7	D interval of dCO_2 control loop		f	RW
3.1.4.n.8	Bias of dCO_2 control loop	-/+400	f	RW
3.1.4.n.9	Freeze value of dCO_2 control loop	-/+400	f	RW
	n = 1 - 4*			
3.1.5.n.1	Desired situation of level control loop (0 or 100)	0,100	f	RW
3.1.5.n.2	"currently not in use"		f	R
3.1.5.n.3	"currently not in use"		f	R
3.1.5.n.4	"currently not in use"		f	R
3.1.5.n.5	"currently not in use"		f	R
3.1.5.n.6	Lag time of level control loop		f	RW
3.1.5.n.7	Maximum on-time of level control loop		f	RW
3.1.5.n.8	"currently not in use"		f	R
3.1.5.n.9	"currently not in use"		f	R

FUNCTION GROUP 4: OUTPUT CONTROL

F-code	Functional Description	Range	Format float or # of chars.	Read Write Command
	o = 1 or 2: analog output 1 or 2			
4.5.o.1	Value to correspond with 0/4 mA of analog output		f	RW
4.5.o.2	Value to correspond with 20 mA of analog output		f	RW
4.5.o.3	Low limit of analog output		f	RW
4.5.o.4	High limit of analog output		f	RW
4.5.o.5	Engineering unit of analog output	0 - 33	f	RW
	o = 1 - 9: digital output 1 - 9			
4.6.o.1	Value of digital output	0 - 100	f	R
4.6.o.2	Cycle time of digital output	0, 0.4 -	f	RW
4.6.o.3	Low limit % of digital output	0 - 100	f	RW
4.6.o.4	High limit % of digital output	0 - 100	f	RW
4.6.o.5	Dose monitor value of digital output		f	R
4.6.o.6	Addition rate of dose monitor		f	RW
4.6.o.7	Engineering unit of dose monitor	0 - 33	f	RW
4.6.o.8	Map dose monitor value to recorder (0 = unmapped, 1,2 = output)	0,1,2	f	RW
	o = 1 - 9: digital output 1 - 9 (only valid if defined as Timer)			
4.7.o.1	On time of digital output (timer function)	0, 0.2 -	f	RW
4.7.o.2	Off time of digital output (timer function)	0, 0.2 -	f	RW
4.7.o.3	Delay time of digital output (timer function)	0, 0.2 -	f	RW

FUNCTION GROUP 5: OUTPUTS

F-code	Functional Description	Range	Format float or # of chars.	Read Write Command
	o = 1 or 2: analog output 1 or 2			
5.1.o	Value of analog output		f	RW
	o = 1 - 9: digital output 1 - 9			
5.2.o	Status of digital output (0 = off, 1 = on)	0,1	f	RW

4. ADDITIONAL REMARKS:

- Serial configuring of outputs is only valid when the controller is not running or not configured at all.
- Low and high limits of outputs can only be editted when the controller is not running.
- List of commands for serial keyboard emulation:

> = Enter	# = Clear	@ = Freeze	M = Main	P = UP
A = F1	B = F2	C = F3	D = F4	E = F5
0 = 0	1 = 1	2 = 2	3 = 3	4 = 4
5 = 5	6 = 6	7 = 7	8 = 8	9 = 9
. = . (period)	- = - (minus)			

- Table of number codes used in operation control:

Data	6.1.t.n Controller		6.2 Process Timer		6.3.o Timer		6.4.o Dose Monitor	
	Read	Command	Read	Command	Read	Command	Read	Command
1	Not Active	Stop	Not Active at 0 sec.	Stop	Not Active	Stop	Undefined	Undefine
2	Active	Start	Active	Start	Active	Start	Active	Define
3	Frozen	Freeze	Interrupted	Reset	Alarm or Controller	Define		Reset
4		Unfreeze			Free	Undefine		

- The I- and D-intervals (3.1.t.n.6 and 3.1.t.n.7) must be given in seconds.
- Writing data to outputs using the functions 4.5.o.x and 4.6.o.x is only valid when these outputs are properly configured.
- Mapping a Dose Monitor (output 1 - 9) to a recorder is only valid when the corresponding analog output was not yet in use. Writing function 4.6.o.8 will define the analog output as a recorder and copy the engineering unit from the dose monitor to the analog output.
- The maximum time value in the ADI 1030 display is 9999:59:59 (HHHH:MM:SS). This gives a range in seconds of 0 - 35999999. The On, Off and Delay times have a resolution of 1 sec. The sum of On and Off time (= cycle time) may not exceed 35999999 sec.
  Values become effective immediately if possible; otherwise at the beginning of the next cycle.
- In case the temperature correction method and corresponding data is done by serial communication, the following procedure must be used:
  - In case a fixed correction needs to be changed in a temperature input correction: first write the temperature input number to 2.2.1.3, next write value 2 to 2.2.1.n.2.
  - In case a temperature input correction needs to be changed to a fixed correction: first write the value 1 to 2.2.1.n.2, next write the correction temperature to 2.2.1.n.3.

5. ERROR CODES:

Whenever and error occurs in receiving or interpreting the command-string, the ADI 1030 Bio Controller responds with an error-message. An error-message is coded by using an 'E' character at the position of the command separator:

<stx>[N*to,from*][F*code*|B*code*|L*code*][U*unit*]E*code*<cr>[<lf>]

The data-section contains a number that represent an error-code. Each error (error-source) has its own error-code. These errors are:

Communication-Line Errors (all starting with 1)

11 **parity error**
parity fault during the reception of the command-string; check for correct setting of the parity (none, even, odd) on both devices (Bio Controller and host).

12 **framing error**
no stop-bit is, or not enough stopbits are, detected at the end of the character. Check the number of stop-bits (1 or 2) and data-bits (7 or 8) on both devices.

13 **USART overrun error**
a character of the command-string is not read in time (by the Bio Controller), the next character has overrun its predecessor; set the correct baud-rate (i.e. use a lower baudrate) or use handshake (X-on / X-off)

Data-Errors (starting with 2)

21 **syntax error**
the received command-string can **not** be interpreted by the Bio Controller.

22 **numerical error**
the numerical data in a section is not correct, the numeric-field (i.e the section where the number is expected) contains no numerical characters, contains a non-numerical character, or contains too much numerical-characters.

23 **internal buffer overflow**
too many data is send to the Bio Controller in one command-string. The maximum length of the command-string is 128 characters including the <stx> and <cr>.

24 **checksum error**
the received checksum is not correct.

25 **checksum expected / checksum not expected**
no checksum is received while expected or a checksum is received while not expected.

6. COMPATIBILITY WITH FORMER COMMUNICATION PROTOCOL:

An ADI 1030 Bio Controller with a previous firmware version (e.g. V1.3X) uses a different (old) protocol. For this reason, the firmware version V2.0X also supports this old protocol, however its application is limited.

Note:
- The format of the first request by the host after "power up" of the ADI 1030 Bio Controller determines which protocol is selected by the ADI 1030. Switching of communication protocol is only valid after "power off/on".

Communication with use of the "old" protocol is based on the following strings:

Data request (or command) string: B1, B2, B3, B4, B5.

Byte	Description	
B1	Start of text (ASCII 2)	CHR$(2)
B2	Bio Controller device number to be addressed followed by command separator <,>	MA (A=1 to 99)
B3	Request or command followed by command separator <,>	See tables on next pages
B4	Value (optional, only in case of a command)	
B5	String termination	CR

Reply string: B1, B2, B3, B4, B5

Byte	Description	
B1	Start of text (ASCII 2)	CHR$(2)
B2	Bio Controller device number identification followed by command separator <,>	MA (A=1 to 99)
B3	Request or command followed by command separator <,>	See tables on next pages
B4	Reply	
B5	String termination	CR, LF

COMMANDS FOR SERIAL COMMUNICATION (old protocol):

On these pages, the commands (function codes, composed like FXYZ) that can be used in serial communication (old protocol), are listed. The page number indicates at which page in the corresponding user manual the function is explained.
The code R means "read only", the code R/W means "read and write".

GENERAL GROUP:

FX	Sensor input value (X = 1 .. 4), p 2-3	R
F5	Uref value (service menu), p 2-25	R
F6	Ubat value (service menu), p 2-25	R
F7	Firmware version (service menu), p 2-25	R
F62	Device number, p 2-24	R

GROUP 1: P.I.D. parameters (Y = 1 .. 4, controller number)

F1Y0	Setpoint, p 2-15	R/W
F1Y1	P-gain, p 2-15	R/W
F1Y2	Integral time, p 2-15	R/W
F1Y3	Derivative time , p 2-16	R/W
F1Y4	Dead zone, p 2-16	R/W
F1Y5	Process time, p 2-22	R/W
F1Y6	Range low, p 2-17	R/W
F1Y7	Range high, p 2-17	R/W
F1Y8	Output #, p 2-18	R/W
F1Y9	Bias value, p 2-16	R/W

GROUP 2a: Output status (Y = 1 .. 9, solid state number)

F2Y	Solid state output number (0 = off, 1 = on), p 2-12	R

GROUP 2b: Calibration (Y = 1 .. 4, input number)

F2Y1	Value of first buffer, p 2-8	R
F2Y2	Value of second buffer, p 2-8	R
F2Y3	Obtained slope, p 2-8	R
F2Y4	Obtained offset , p 2-8	R
F2Y5	Buffer temperature, p 2-8	R
F2Y6	Temp. correction (pH calib. only), p 2-11 1 = fixed temp. correction 2 = automatic temp. correction	R
F2Y7	Data for F2Y6: temperature for fixed correction or number of temp. amplifier (auto corr.)	R

7. IDENTICAL FUNCTIONS IN OLD AND NEW PROTOCOL:

The firmware V2.0 does not use the following parameters any longer:
- Process Time (F1Y5),
- Range Low (F1Y6) and
- Range High (F1Y7).

In the firmware V2.0, the Freeze values are defined per control loop in stead of per output (F5Y4 and F7Y5).
As a result, these functions can not be found in the function list of the new Applikon communication protocol.
In the list below, the corresponding functions can be found; if a direct replacement does not exist due to changes in the firmware, the alternative is given between braces.

Old protocol	Description	New protocol
Fx	Sensor input value (x = 1 - 4)	1.1.t.n
F5	Uref value	0.1.1
F6	Ubat value	0.1.2
F7	Firmware version	0.2.2
F62	Device number	0.2.3
F1Yx	Parameter list (x = 0 - 9)	3.1.t.n.y
F2Y	Digital output status	5.2.0
F2Y1	First buffer value	2.1.t.n.3
F2Y2	Second buffer value	2.1.t.n.4
F2Y3	Obtained slope	2.1.t.n.1
F2Y4	Obtained offset	2.1.t.n.2
F2Y5	Buffer temperature	2.1.t.n.5
F2Y6	Temperature correction	2.2.t.n.2
F2Y7	Data for F2Y6	2.2.t.n.3
F3Y	Analog output value	5.1.o
F3Y0	Dosed value	4.6.o.5
F3Y1	Addition rate of dose monitor	4.6.o.6
F3Y2	To output 10/11 (analog 1/2)	4.6.o.8
F4Y0	Value to output 10/11 (analog 1/2)	2.5.t.n
F4Y1	Low alarm limit	2.4.t.n.2
F4Y2	High alarm limit	2.4.t.n.3
F4Y3	Low alarm output	2.4.t.n.5
F4Y4	High alarm output	2.4.t.n.6
F5Y0	Low limit of analog output	4.5.o.3
F5Y1	High limit of analog output	4.5.o.4
F5Y2	Engineering unit	4.5.o.2
F5Y3	Suffix code	4.5.o.5
F5Y4	Freeze value	(3.1.t.n.9)

BIO CONTROLLER

ADI 1030

PID CONTROL MANUAL

applikon®
DEPENDABLE INSTRUMENTS

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PID CONTROL MANUAL

INTRODUCTION

This manual deals with practice and theory of P.I.D. control with the ADI 1030 Bio-controller; it is an addition to the User and Operator manual.
In this manual, controller variables and controller parameters are defined and the way of optimizing the settings is explained.

Abbreviations, used in this manual, in alphabetical order:

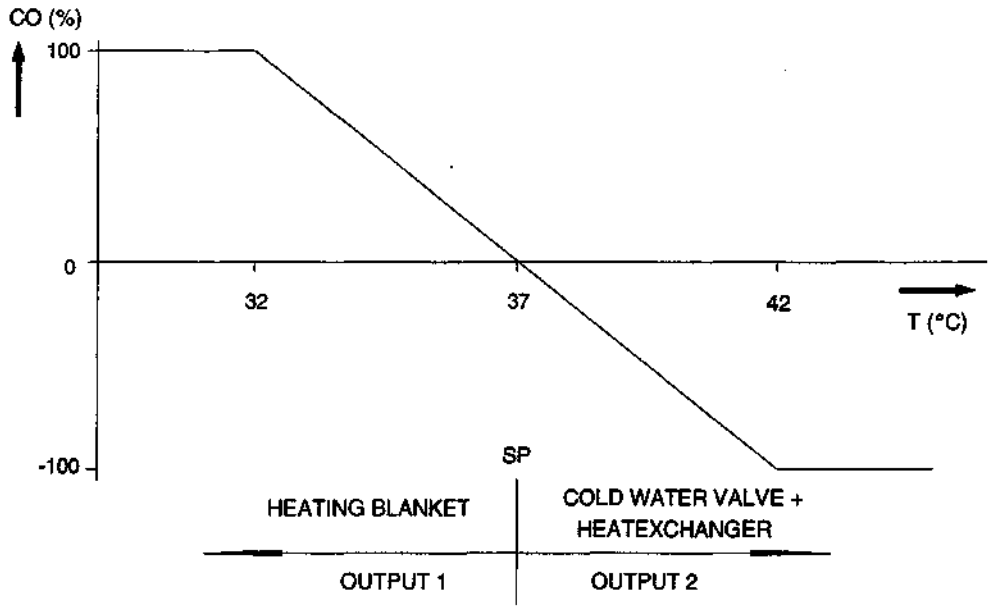
AO - **A**ctuator **O**utput
B - **B**ias
CO - **C**ontroller **O**utput
D - **D**erivative time
DZ - **D**ead **Z**one
HL - **H**igh **L**imit
I - **I**ntegral time
LL - **L**ow **L**imit
P - **P**roportional gain
PV - **P**rocess **V**alue
SP - **S**et**P**oint

2. CONTROLLER-TUNING PARAMETERS

2.1 PROPORTIONAL GAIN: P (% per eng. unit)

Proportional gain is the parameter for proportional control. The controller action due to proportional control is relative to the deviation from setpoint. The proportional gain is defined as the change in controller output per engineering unit. The equation for proportional control is:

$$COp = P*(SP-PV)$$



Temperature control with two actuators.

This paragraph is continued on the next page.

2.3 DERIVATIVE TIME: D (time units)

Derivative time is the parameter for derivative control. Derivative control is used to compensate for very fast changes of a process value. The mathematical expression for derivative control is:

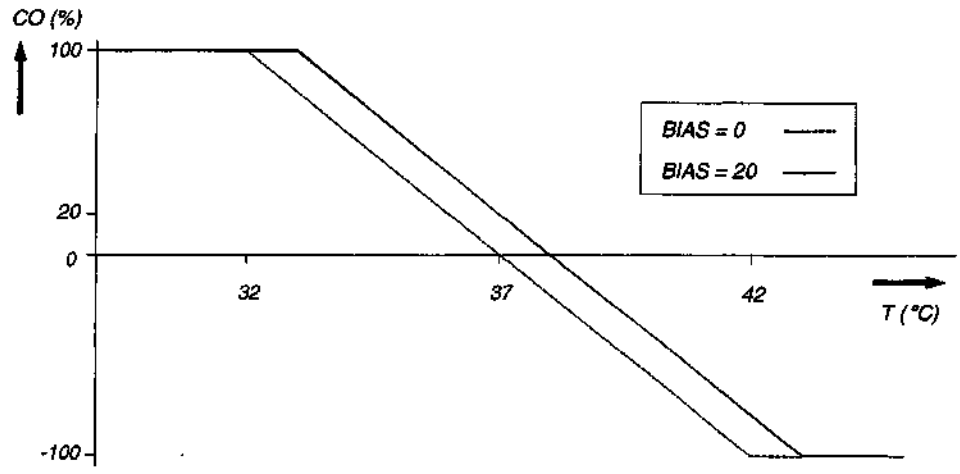
$$COd = P * D * \frac{\partial(SP-PV)}{\partial t}$$

Due to the fact that biotechnological processes are relatively stable and slow, this derivative part of P.I.D. control is normally not in use in these kind of applications.

2.4 BIAS: B (%)

The bias can be used to compensate for a constant offset from setpoint and is defined as the controller action at setpoint in the absence of integral and derivative action. Bias is added to the controller output, which results in:

$$CO = B + COp + COI + COd$$



Bias in temperature control

If the integral part of the controller action is constant, it can be replaced by a bias value; as a result, the controller will reach the setpoint more quickly, since no history is required to reach the optimum value.

3. ACTUATOR VARIABLES

3.1 ACTUATOR OUTPUT: AO (%)

The actuator output relates to the actuator action. The actuator output can vary in the range from 0% to 100%.
In case of the digital outputs 1 through 9, the actuator output % relates to the on-time of the actuator (% of the cycle time).
In case of the analog outputs 10 and 11, the actuator output % relates to "force" of the actuator.

4. ACTUATOR PARAMETERS

4.1 LOW/HIGH LIMIT: LL/HL (%)

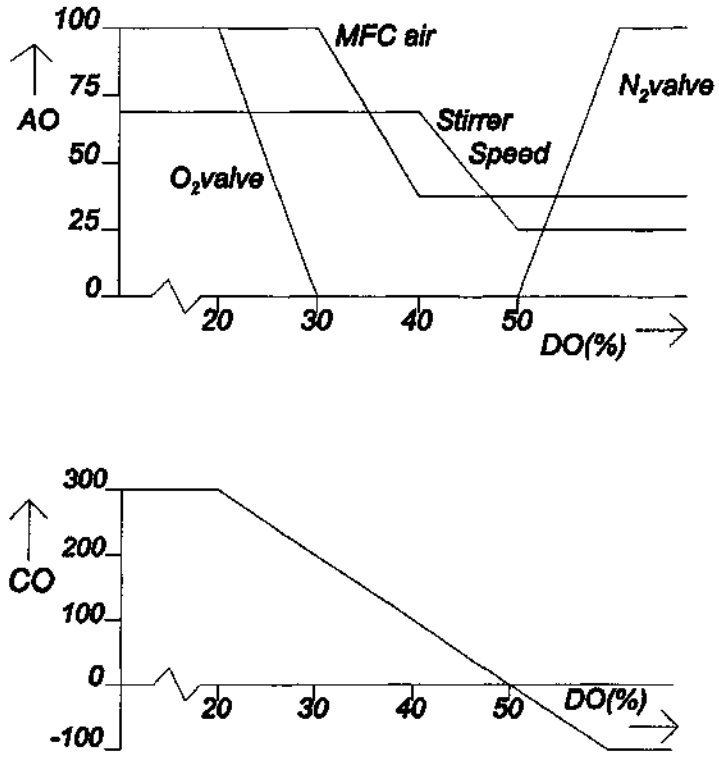
The low limit is the minimum output activation. The high limit is the maximum output activation. These limits are used to assign the minimum Controller Output to the Low Limit value and the maximum Controller Output to the High Limit value.
An example of this application is using a stirrer speed controller in dO_2 control; the Low Limit can be set to 350 rpm, the High Limit can be set to 650 rpm. Full control range is now 350 rpm to 650 rpm.

4.2 CYCLE TIME (time units)

The cycle time is only relevant for digital outputs and defines the control interval (duty cycle) of a digital output. Furthermore, the proportional, integral and derivative controller action is updated after a time interval of one cycle time.

5.2 SEQUENTIAL CONTROL

Sequential control is used to control a process variable with more than one actuators (maximum = 4).
The actuators will be activated sequentially as configured in the configuration menu (see chapter 5 in the User Manual).
The figures below show an example of sequential control (both AO and CO versus % Dissolved Oxygen).



Sequential dissolved oxygen control.

infrared lamp	D	MC
hot finger	D	MC

Actuators for cooling

	output	application
cold water valve (+ heat exchanger)	D	exothermic culture
cryostat (+ heat exchanger)	A	exothermic culture

Heat exchangers

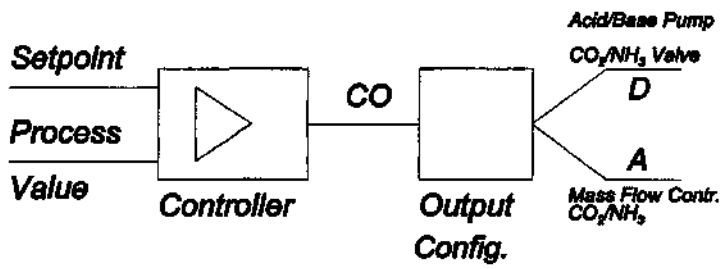
	application
jacket	CC
finger	MC
baffles	MC
draft tube	MC

6.2 pH CONTROL

pH has to be controlled within a narrow range. Therefore, a P-control with a high P-value is required. To prevent that salt production will occur around setpoint (due to excessive addition of acid and base), a dead zone is being used; therefore both integral and derivative time are 0.

Sensor
A combined pH-glass electrode is used as a sensor; this sensor is normally calibrated with two pH buffers.

Features
Calibration of the pH electrode is normally executed before sterilizing the reactor.



Actuators for oxygen addition

	output	application
stirrer speed controller	A	CC/MC
air solenoid valve	D	CC/MC
air mass flow controller	A	CC/MC
oxygen solenoid valve	D	CC/MC
oxygen mass flow controller	A	CC/MC

Actuators for oxygen dissipation

	output	application
nitrogen solenoid valve	D	CC/MC
nitrogen mass flow controller	A	CC/MC

Aeration

	application
sparging	MC
sparging with filter	CC
head space (overlay)	CC
spin filter	CC
silicon tubing	CC

6.4 LEVEL CONTROL

Sensor
A level detector is used as a sensor; this sensor will or will not detect a closed circuit.

Actuator for level control

	output	application
pump for anti-foam reagent	D	MC

7.3 EXAMPLES

When the Bio Controller is operated for the first time, setting the PID parameters might be a bit complicated; therefore some examples are given below as a rule of thumb for different applications (temperature, pH, and dO_2).

TEMPERATURE CONTROL

Direct heating (heating blanket, hot finger or jacket) and cooling (cold finger or jacket).

Parameter	Value
Setpoint	X
P-gain	20
Integr. time	4500
Deriv. time	0
Dead zone	0
Bias	0
Cycle time	30

pH CONTROL

System 1: Pump for acid and pump for alkali.

Parameter	Value
Setpoint	X
P-gain	50
Integr. time	0
Deriv. time	0
Dead zone	0.05
Bias	0
Cycle time	30

dO_2 CONTROL

System 1: Continuous air sparging and stirrer speed control.

Parameter	Value
Setpoint	X
P-gain	10
Integr. time	3000
Deriv. time	0
Dead zone	0
Bias	0
Cycle time	30

Note:
- The low and high limit for stirrer speed control must be selected in such a way, that the required minimum and maximum stirrer speed are not exceeded.

System 2: Continuous air sparging, N_2 and O_2 controlled, head-space only.

Parameter	Value
Setpoint	X
P-gain	20
Integr. time	6000
Deriv. time	0
Dead zone	0
Bias	0
Cycle time	30

Braak-ter, Dennis

From: Rob Claeijs [servicebio@applikon.com]
Sent: Friday, May 07, 2004 10:07 AM
To: Braak-ter, Dennis
Cc: Service Bio; Frank van den Hoogen
Subject: ADI1030

ADI1030_jumpers for analog out...

Geachte heer Ter Braak,

Bijgevoegd vindt u een tekening van het processord bord van de ADI1030.
In de linker bovenhoek ziet u 2 x 2jumpers.
Voor uitgang 1 worden jumpers X3 en X5 gebruikt.
Voor uitgang 2 worden jumpers X7 en X9 gebruikt.

Op de tekening staat rechts boven hoe de jumpers moeten staan aan de hand van welk uitgangssignaal u nodig heeft. De uitgang zal nu op 4-20mA staan, dit moet gewijzigd worden naar 0-20mA.

With best regards,
Applikon Biotechnology
Department Technical Service
Rob Claeijs

++
telephone: +31 10 2983404
faxcimile: +31 10 4379648
email: servicebio@applikon.com
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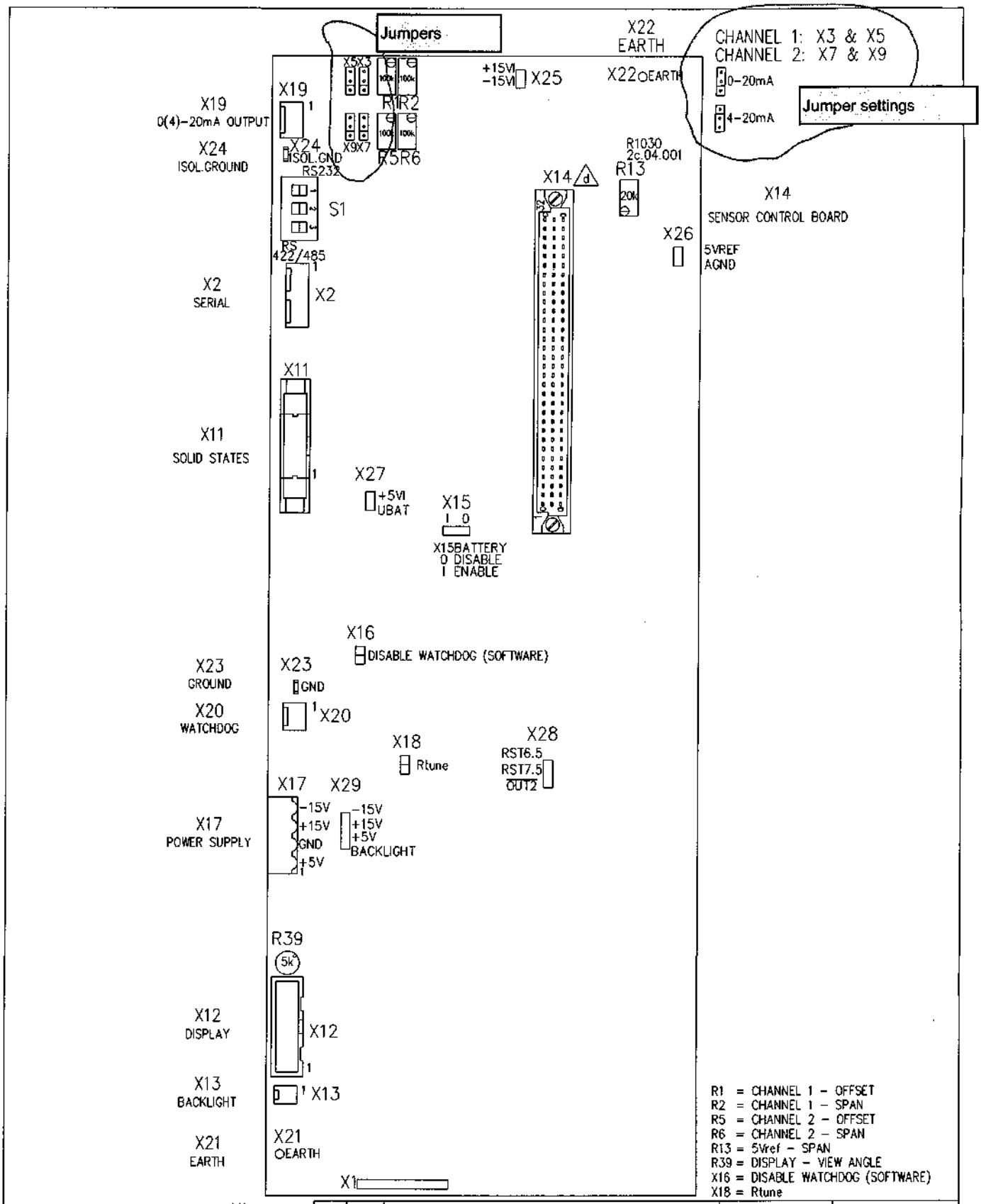

REV.	DRAWN	REVISION	REVISION DATE	CHECKED
d	NGa	X14 TYPE CHANGED.	29 jan. 2002	HMa
c	RHu		16 jun. 1995	16 jun. 95 RCI

PROJECTION :

DRAWING NAME : CONTROLLER BOARD

applikon® BIOTECHNOLOGY

PART NBR.:	V1LE040012	DRAWING NBR. :	S1030-2d.04.001	
SCALE :	1 : 1			
DESIGNED :	20 mar. 1991	RHu	APPR.:	SHEET: 1 OF 1
CHECKED :				attached drawings

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DIMENSIONS ARE IN mm

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SIZE : A3